THE

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LOAD FACTOR.

THE question of what is the best definition of the term load factor has recently been brought into prominence as the result of the divergence of opinion shown to exist amongst speakers in the discussion on Mr. Hammond's paper "On the Cost of Generation and Distribution of Electrical Energy;" and, in consequence of this want of accord amongst electrical engineers, Mr. Hammond, in a letter which appeared recently in the columns of a contemporary, has explained his own views more fully than he was able to do when replying to the discussion on his paper, and has invited discussion with a view of settling once for all the definition of the term "load factor." In this letter Mr. Hammond claims that a complete agreement was come to as to the definition of this term in the discussion on Mr. Crompton's paper, which was read in 1891 at the Institution of Civil Engineers, and in which the term load factor was first employed; and although we must confess that the discussion itself did not evidence a complete agreement, yet the final definition given by the author of the paper in his reply to the discussion is the one which has been almost universally adopted; and, when any one has spoken of the load factor, it has been understood to mean the ratio of the actual units generated during the year to the product of the maximum output in kilowatts at any time during the year into the total number of hours in the year.

Although the above definition is, we believe, the generally accepted one, yet the term is often used, sometimes with and sometimes without qualification, to express other ratios than the one named above; the reason being that there are a number of factors all of the nature of load factors which influence the total cost of a unit of electricity, and that sometimes one and sometimes another of these factors is the most important in its effect according to the particular point which is being examined. Take, for instance, the load factor to which Mr. Hammond takes objection, and which is based on plant capacity, we can find three different definitions, each of which has its special utility. If the denominator of the ratio is the maximum plant capacity multiplied by the number of hours, we have a factor which has a decided effect on the financial results; since, if the plant is of greater capacity than is necessary, capital is lying idle, and interest has to be paid on plant which has no earning power. Again, if the maximum capacity of the plant in use at the time of greatest demand appears in the denominator, the factor so obtained has a great effect on the coal consumption and evaporative efficiency of the boilers, and also on the labour bill; and this factor is extremely useful in comparing the results of one week with another, or one month with another. The third factor is one in which the denominator expresses the sum of the products of maximum output of each engine and dynamo into the number of hours

it has been in service, and this factor, which gives the ratio of the actual average output of each steam plant during running hours to its maximum output, is the one which affects the steam consumption per unit.

Another factor which affects the financial results may be termed the lamp-hour load factor, and is obtained by making the denominator equal to the product of the output required for the total lamps connected into the number of hours, and this is useful as a basis of comparison of the earning power of the distributing plant. Although all these factors have their utility, we do not think that any of them have a claim to be called "the load factor," as compared with the one based on maximum output, unless it be the factor based on the maximum capacity of the plant in use at the time of greatest demand. This latter factor, we consider, gives a truer basis of comparison for works' cost than any other, if the load factor for the year is calculated by taking the average of the daily or weekly load factors. For example, the load factor each day will be the ratio of the number of units generated to the capacity in kilowatts of the plant in use at the time of greatest demand multiplied by 24, or for each week the similar ratio with a multiplier of 168 instead of 24; and the load factor for the year will be the average of the 365 daily or the 52 weekly load factors.

This averaging of daily or weekly load factors, whether they are based on maximum units generated or maximum plant capacity in use at the time of greatest demand, gives a factor for the year which is much more useful than one based on the absolute maximum at any time during the year; and of the two ways of calculating the daily or weekly load factor, we consider that the one which depends on plant capacity is the more useful. This averaging is advantageous, not only for the reason given by Mr. Hammond that it takes into account the fact that the lamp connections are continually increasing in number, but because it takes into account the variations of the daily load curve at the different seasons of the year; and these variations are equally important, whether the number of lamps connected has doubled in the 12 months, or has remained stationary. For example, if we take two districts, in one of which the demand is very largely for the lighting of residential and other buildings which require to be fully lighted for a certain time every evening throughout the year, whilst in the other the demand is chiefly for the lighting of shops which close early enough not to require any artificial light during the summer months; we may get equal load factors if we calculate on the absolute maximum demand or capacity of plant in service; and yet the shop district, which would give the higher load factor calculated by averaging the daily or weekly factors, would be the cheaper district to supply as far as generating costs are concerned, because in the summer months a smaller number of boilers would have to be lighted and fewer engines run than for the residential district.

In conclusion, we would remind our readers that, whatever definition is adopted for "the load factor," it will at best be a sort of compromise, as no one factor can be found which will form an accurate basis of comparison between two supply undertakings; and, that if it be desired to compare the conditions of working of two undertakings, all the other factors that we have mentioned, and possibly others that have not been referred to, must be taken into account, whether they be called load factors or by any other name.

The Inconveniences of Acetylene.—We have frequently argued that whatever results are obtained on a small scale in laboratory working with such a thing as an illuminant should not be given to the world as absolute, or as illustrative of that which will attain in practice, and we are interested to notice that our position is fully confirmed in the case of acetylene by the numerous experiments which have been made since this gas came into prominence. In Hungary, at the town of Veszprim, Josef Vértess has been studying the use of acetylene on a large scale at the central station there, and we should like to suggest that it is desirable, for those who are endeavouring to bring this gas into general use, to consider carefully the experiences recorded by Vértess in a paper which may be found in the *Chemiker Zeitung*, Vol. 21, page 174. The paper does not betray any bias, and, indeed, does not go nearly so far as might have been expected, considering the opportunities which exist at Veszprim for an exhaustive examination of the whole subject. However, Vértess has succeeded in recognising a number of inconveniences at present attaching to the use of acetylene in practice, and these may be summed up in the following abstract of his paper:—"The carbide generally contains uncombined carbon, which is carried in the form of fine dust into the pipes, and with the water of condensation forms obstructions in them. In theory, 1,000 grammes of carbide should yield 360 litres of acetylene; the Continental works guarantee only 300, and practice shows that 280—290 is the general yield. Besides free carbon, the carbide contains metallic compounds of sulphur, phosphorous, and nitrogen, and consequently the acetylene evolved contains H_2S, phosphuretted hydrogen and ammonia, the impurities reaching 3—4 per cent. Acetylene ought to be purified in the same way as coal gas, and until that is realised it cannot make much progress as an illuminating agent. The burning of unpurified acetylene in closed rooms is dangerous to health, the most dangerous impurity being phosphuretted hydrogen. There is no doubt that some of the so-called spontaneous explosions have been caused by the ignition of this gas at the temperature existing in the generator. The worst inconvenience of acetylene is the 'smoking of the flame.' The best burners are those with 10—12 small flames, as each flame has a separate atmosphere; even with these, smoking sets in after 200—300 hours' burning. The cause is the decomposition of the acetylene by the heat of the burner; the carbon deposits in the narrow opening of the burner and the flame begins to smoke. Sometimes an oily liquid is formed in the burner, probably a hydrocarbon formed by polymerisation of the acetylene." In conclusion, Vértess says that a very great deal more work must be done before the defects specified in lighting by acetylene can be overcome, and he contents himself by the opinion that it is *absurd* to attempt to produce acetylene for general lighting purposes until the problem of properly purifying it has been overcome.

The Magnetic Properties of Nickel Steel.—Numerous researches have been made on this subject and a good deal of knowledge accumulated, but there is still much to do in checking the results and a great deal more to be done in obtaining further information. Recently E. Dumont has contributed a paper to the Paris Academy of Sciences on this subject (*vide Comptes Rendus*, Vol. 126, pages 741—744.) Dumont has determined the magnetic permeability for fields lying between 14 and 50 C.G.S. units, and for temperatures between — 78° and 250° C., of reversible nickel steels, containing from 27 to 44 per cent. of nickel. The variations of permeability with temperature in the maximum field are continuous, and the curves representing them are roughly parallel to each other, so that at equal distances (of temperature) from the point of total loss of magnetism, all the alloys have the same permeability. At a temperature of 20°, all the alloys show similar changes of permeability, with variations in the magnetising field, rising slowly as the field is strengthened from 14 to 25 units, then rapidly increasing to a maximum in a field of 35 units, and slowly diminishing as the strength of the field is further increased. Under the same circumstances of temperature and strength of field, the permeability increases with the content of nickel.

VIBRATING CABLE RELAY.

By K. GULSTAD.

What to be done in order to produce a suitable cable "relay" is a question which no doubt has troubled the minds of many telegraph people. It is certainly not less interesting at the present time, when the demand for increasing the working speed of submarine cables to their utmost capacity has necessitated the introduction of automatic transmitters on the busiest lines.

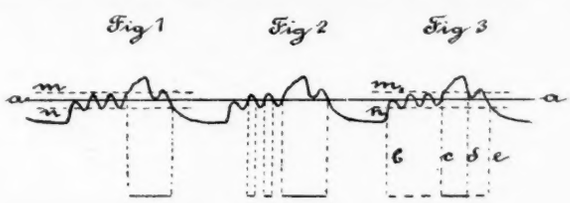
With the exception of some ingenious proposals by Mr. Ch. Cuttriss and others—*vide* the Review, July, 1892—in reference to the reversal system, I am, however, not aware that anything worth mentioning has been published about cable relays since the appearance of the Brown & Allan relay, an instrument which is probably still looked upon as the only veritable cable relay, and which deserves this name, from its being able to act under the influence of varying current strengths, independent of the direction of the current.

It is at the same time hardly necessary to point out that the Brown & Allan relay does not possess all the qualities required for working at high speed, and as an essential point, I may mention that it is unable to give reliable contacts unless its sensibility be sacrificed.

A cable relay, like the Brown and Allan instrument adapted for Morse code signalling, and more especially for automatic working, may, however, be made in quite another way, as described hereafter, which I trust will not prove uninteresting to some of the readers of the Review. The cable relay I refer to is not in principle of any particular construction. Any polarised double current relay may, generally speaking, be used and made into a cable relay, not by way of altered construction, but simply through a special arrangement.

The failure of the polarised relay, when employed as a cable relay in the usual manner, is partly due to want of sensitiveness, but principally to its being unable to respond to variation of currents in one direction only. It is understood that the want of sensitiveness *à priori* is caused by the magnetic attraction between the armature and the nearest pole-piece, a circumstance that gives to the relay its most sensitive state when the pole-pieces are removed to some distance from the armature, although the action of the current through the relay is considerably diminished thereby.

Now this attraction can be done away with, or rather converted into a repulsion independent of the relative position of the pole-pieces. Of course, a relay freed from the attraction would be very sensitive, and it would also respond better to variation of the current than before. In figs. 1, 2, 3, a



cable signal through a relay is represented. Let a be the zero line, and let further the dotted lines m and n, fig. 1, signify the current requisite to overcome the said attraction. As indicated by Morse signals on the sketch, the relay would record the received signal in different ways, according to whether the attraction is neutralised or not, as in fig. 2 and fig. 1 respectively, the effect of distortion in the former case being at least somewhat less.

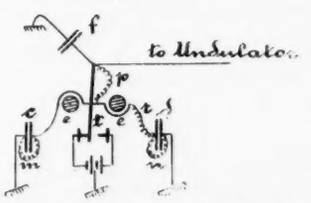
Fig. 3 shows a still better result, and refers to a case of repulsion, or to that particular point which I am going to deal with here. This repulsion of the armature is achieved by arranging the relay as an interrupter in some particular manner, which will make the armature vibrate at a certain rate between the contacts, if the interrupting current be made sufficiently strong. In fig. 3 this rate is supposed to be equal to that of dots sent into the cable; if m_1 and n_1 here represent the current required to stop the vibrations, the relay will accordingly record 3 dots between b c and 1 dot between d e—*i.e.*, the Morse signal as shown.

By thus employing a vibrating relay the effect of distortion is reduced—a most valuable achievement—and all the energy required to move the armature is supplied by the relay current itself, the work left for the cable current being to stop the motion when wanted. This work can be made very small indeed, and means in reality that the relay becomes exceedingly sensitive. One thing is, however, needed, namely, that the vibrations of the tongue can be "tuned," and this being a matter of importance, I propose to treat of it more particularly.

Experiment will show that the plain arrangement of an interrupter will not do when a polarised relay is to be altered into a double current interrupter of required qualities, as the relay might not vibrate at all, or at too high a rate, and too irregularly to be of any use—see fig. 4, where the relay is shown, t being the tongue, e the electro-magnets.

This occurs because the attraction cannot be converted into a repulsion of sufficient strength to make the armature or torque vibrate between the contacts, unless the current be

Fig 6



made so strong, that the rate of vibrations at the same time becomes disproportionately high. If the current be reduced by increasing the resistance, p, in order to get vibrations of a lower rate, the armature may be moved, but only very little indeed, until the contact is broken and the interrupting current ceases to flow; the attraction will then again predominate, viz., the vibrations take place very close to one of the contacts, but not from the one to the other.

In order to overcome this difficulty, I retard the propagation of the interrupting current by applying an inductive capacity, c. Fig. 5, for instance, at point o, in connection with the resistance, r, a little time will pass before the potential at o is raised sufficiently to enable the current to overcome the attraction, but when this is accomplished and the contact broken, the armature will not fall back, but continue its motion from one contact to the other with appreciable energy, due to the fact that the condenser, c, is now partly discharged through the windings and r.

By utilising this principle it is possible to make a relay vibrate at a slow rate, but some alterations of, and additions

Fig 4

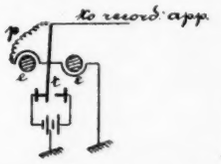
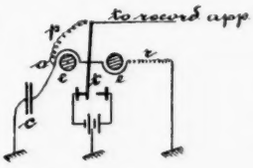


Fig 5



to, the arrangement will nevertheless be found advantageous or necessary to enable the rate to be varied at pleasure.

An appropriate arrangement is sketched out in fig. 6. c, d, f are condensers; n, p resistances; m a large and r a rather small resistance. The relay is differentially wound in the usual manner.

The resistance, p, is put between the tongue and some other point of the circuit than before, say, at the middle of the convolutions. By charging the conductor, c, the tongue is at first pressed against one of the contacts, whence it is removed shortly after. Good contacts are thus fully ensured.

One particular object of the condenser, d, will be evident from the following:—Suffice it here to say that the reversals for high speeds are produced by the difference in charges of c and d, that d increases the rate of vibrations, at the same time somewhat mitigating the rattle of the apparatus, and that d must be shunted by a resistance n, for otherwise the tongue will not vibrate, or, at least, not steadily. The condenser, f, is inserted to avoid or make up for other causes of trouble, viz., the sparking between the contact points, minute mechanical vibrations, &c., in virtue of the condenser main-

taining the electrical potential of the tongue for a little while, when it moves from one of the contacts.

With suitable condensers the relay, arranged as described, can be made to vibrate practically at any pitch—by varying the resistances, &c.—with beautiful regularity, as will be observed from the relay records, fig. 7, on the slip of an "undulator," a recording instrument described in the REVIEW, January 29th, 1892, page 130.

Fig 7

Fig 8

Fig 9

Such vibrations give an interesting illustration of the retarding effect accompanying the charge of condensers combined with resistances and effect, which for large condensers, *c*, and cables can be extended to such a degree that the armature only is reversed once every half second or more. Under certain conditions irregular vibrations can also be had—see record fig. 8—for instance, when the direct action of the resistance, *n*, is about to be overpowered by the action of the condenser, *d*, or *vice versâ*.

In some instances the different action of the condenser and resistance can be produced instantly, without any period of transition—see record fig. 9—causing the rate of vibrations to be changed suddenly.

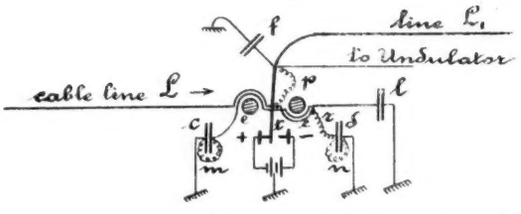
A curious thing can be observed in connection herewith, namely, that the tongue is able to vibrate at two different rates under the same conditions, although the vibrations are stable for one rate only.

This shows that the vibrations or the condenser oscillations keep their pitch at any moment with a persistence that can only be overcome by a certain force. In fig. 9 the different rate of vibrations is not produced by altering the connections, but by slightly tapping the base of the apparatus.

In the regulations to be described later on, one must, of course, not make any connections, which tend to cause such irregular vibrations.

The application of the vibrating relay for working can be effected as shown in fig. 10, L being line or cable, whence

Fig 10



the current passes through one set of windings to the cable condenser, *l*, while the vibrating current acts through another separate set of windings. Condensers and resistances are marked as above.

Suppose, now, that a positive marking current in the direction of the arrow moves the armature and tongue to the right, and recalling to mind that the cable current has to stop the vibrations and keep the tongue against the right-hand contact, the poles of the relay battery must be connected as shown, i.e., in such a way that the translated marking current through line L_1 is of opposite sign to the corresponding cable current.

(To be continued.)

CATHODE RAYS IN AN OSCILLATING ELECTRIC FIELD.

THE theory of the cathode rays most in favour among physicists in this country is that which assumes that the rays consist of a stream of particles charged with electricity. This theory has not been generally accepted in Germany, though recently it has made a few converts.

One apparently fatal objection urged against the view that the cathode rays consist of charged particles, is that they are not deflected by an electrostatic force. If these rays consist of electrified particles, one would expect *prima facie* that they would be more susceptible to an electrostatic force than to a magnetic force. The reverse, however, is the case. They can be readily deflected by a comparatively weak magnet; but Hertz found that no deflection was produced when the rays passed between two plates connected to a battery.

Prof. J. J. Thomson makes an ingenious attempt to explain away this anomaly in the charged particle theory. He says:* "We must remember, however, that the cathode rays, when they pass through a gas, make it a conductor, so that the gas acting like a conductor, screens off the electric force from the charged particle, and when the plates are immersed in the gas, and a definite potential difference established between the plates, the conductivity of the gas close to the cathode rays is probably enormously greater than the average conductivity of the gas between the plates, and the potential gradient on the cathode rays is probably very small compared with the average potential gradient" He also describes an experiment in which a deflection can be produced when the electrostatic field is caused to act on the dark space next the cathode, and this he explains by the hypothesis that the gas in the dark space is either not a conductor at all, or, if a conductor, a poor one, compared with the gas in the main body of the tube.

An interesting experiment is described by J. J. Thomson, which illustrates this curious resistance of the dark space to the passage of the cathode rays. Two spherical bulbs were connected together by a glass tube; one of these bulbs was small, the other large; they each contained a cathode, and the pressure of the gas was such that the dark space round the cathode in the small bulb completely filled the bulb, while that round the one in the larger bulb did not extend to the walls of the bulb. The two bulbs were wound with a wire which connected the outsides of two Leyden jars; the insides of these jars were connected with the terminals of a Wimshurst machine. When sparks passed between these terminals, currents passed through the wires and induced currents in the bulbs, which caused a ring discharge to pass through them. Things were so arranged that the ring was faint in the larger bulb and bright in the smaller one. On making, however, the wires in these bulbs cathodes, the discharge in the small bulb, which was filled by the dark space, was completely stopped, while that in the larger one became brighter. Prof. Ebert has also shown that a cathode stream is deflected out of its straight path by creating a dark space in its way.

The charged particle theory gives no satisfactory explanation of this curious property of the dark space; and though some ingenious experiments, similar to that of Perrin, have been devised by J. J. Thomson to show that the cathode rays discharge negative electricity on anticathode conductors, yet, while so many important phenomena remain inexplicable by this theory, it appears advisable, for the present, to suspend our judgment.

Jauman also obtained a deflection of the cathode rays by placing a conductor close to the side of the tube just in front of the cathode. But this has been shown by Schmidt and Wiedemann † to be due to a displacement of the starting point of the cathode rays owing to the change produced in the electric field by the presence of the charged conductor, and not to a deflecting influence exerted on the cathode rays by the electrostatic field. The deflection obtained by J. J. Thomson may be explicable in the same way, since the conditions of his experiment were very similar to those of Jauman.

Though it is still doubtful whether the stationary electric

* Royal Institution Lecture, April 30th, 1897, p. 10.

† E. Wiedemann & G. C. Schmidt, *Wied. Ann.*, 60, p. 510, 1897.

field produces any deflection of the cathode stream, it has been recently shown by Schmidt * that unmistakable deflections are produced by an oscillating electric field. The conditions of the experiments made by Schmidt exclude the possibility of the deflections being due to a displacement of the starting place of the cathode rays.

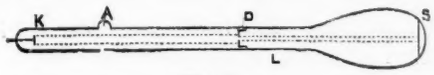


FIG. 1.

Schmidt's experiments were made with a special vacuum tube designed by Braun.† In this tube, illustrated in fig. 1, K is the cathode disc, and A is the anode. At D is an aluminium diaphragm with a central aperture about 2 mm. in diameter; S is a disc of mica coated with phosphorescent material, on which the phosphorescent spot can be seen through the glass when looking at the end of the tube.

If an insulated metal plate is brought near the tube in the neighbourhood of L, the phosphoresent spot widens out a little. This phenomenon is intensified if the plate or, in its place, a brass ball is connected to the cathode pole of the induction coil. Under these circumstances a comet-like tail is thrown out from the side of the spot opposite to the inducing body. The appearance of some of these comet tails is shown in fig. 2.

FIG. 2.

Since the publication of Schmidt's experiments, this subject has been taken up and thoroughly investigated by Prof. Ebert, of Kiel.‡ Instead of the induction coil, Ebert used a small alternating dynamo driven at the highest possible speed by an electro-motor. This machine generated an alternating current with a frequency of 60,000 per minute. The E.M.F. of this current was raised by a Siemens spark inductor with the condenser removed to 1,500 volts. The terminals of the secondary of this coil were connected to a pair of condenser plates placed at opposite sides of the Braun tube close behind the diaphragm. The cathode rays in the tube were produced by an influence machine. Ebert's arrangement, therefore, differs from Schmidt's in several features. (1) With Ebert's apparatus the oscillating electric field is persistent and regular, while in the Schmidt arrangement it is irregular and quickly damped, owing to the oscillations being derived from the ordinary induction coil. (2) The source of the oscillating field is independent of the source of the cathode rays in Ebert's arrangement, while in Schmidt's they are both derived from the same source, viz., the secondary of an induction coil.

Ebert satisfied himself, by experiment, that the time changes of the electric field between the condenser plates were almost perfectly sinusoidal, and followed one another without a break. With this apparatus were obtained not only comet-tail extensions of the nucleus spot on the phosphorescent screen, but well defined deflected rays could be seen, which, in the rotating mirror, were drawn out into oscillation curves of the greatest regularity.

* K. E. F. Schmidt, *Abhandl der Naturforsch-Gesellschaft zu Halle*, 21, p. 163 and 173, 1897.
† *Wied. Ann.*, Vol. 60, p. 552.
‡ *Wied. Ann.* 64, p. 240, 1898.

The two metal plates, P_1 P_2, fig. 3, having each a surface of 3·7 × 6·8 cm., were formed into a small condenser by fixing them at one end to a block of vulcanite, S_2, 2·5 cm. thick. These plates projected far enough over the vulcanite to embrace the tube, B. When the machine was started, the spot on the phosphorescent screen was drawn out into a thick vertical band of about 3 cm. in length. This experiment, therefore, proves that in the oscillating electric field cathode rays are distinctly deflected, and always in the direction of the lines of force, the latter assertion being easily demonstrated by turning round the condenser. The deflection in this case cannot be explained on the theory of the displacement of the starting point of the cathode rays, since that was 30 cm. distant from the condenser plates, and it was found that these plates lost their deflecting power if they were moved away from the tube even a few centimetres. The deflection is greater the greater the surface of the plates, and it also increases if the condenser is moved towards the end of the tube, as if the amplitude depended on the leverage at which the condenser acted. The deflection also increases with the potential difference between the plates.

Ebert suggests three different theories to explain this deflection effect of the oscillating electric field, and then proceeds to examine these theories by crucial experiments to determine which gives the correct explanation. He considers it possible that the deflection may be due to :—

I.—The magnetic effect of the displacement currents in the dielectric.

II.—The electrostatic charges on the walls of the vacuum tube.

III.—The deflection effects of secondary cathode phenomena.

I.—The Influence of the Displacement Currents.

The displacement currents of Maxwell's theory oscillate backwards and forwards along the electrostatic tubes of force, and would consequently give rise to circular magnetic lines of force surrounding each tube. These magnetic circles are equivalent, according to Stokes's theorem, to a shell of rectangular magnetic lines of force lying in the planes joining the edges as the condenser plates. The magnetic effect of these lines would tend to deflect the cathode rays in exactly the same direction as is shown by Schmidt and Ebert's experiments. But it remains to be seen whether in other respects this magnetic force is sufficient to account for the phenomena observed.

Ebert makes use of several arguments to show that, notwithstanding this partial agreement between the predicted and the observed results, the deflections are *not* due to the influence of the displacement currents. One of the strongest is the answer to the following question : Is the movement of the cathode rays in phase with the charging of the condenser, or with the displacement current? If G is the electrostatic potential gradient, the displacement current is determined by dG/dt, and therefore differs in phase from the charging of the condenser by a quarter period. If the deflection is due to the

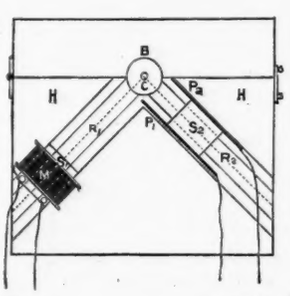


FIG. 3.

magnetic effect of the displacement current, it should have a phase displacement of about 90° relatively to the curve of tension. In order to determine this point, the primary current of the transformer was made use of for comparison. By causing the two forces, whose phases are to be compared to act on the cathode beam at right angles, the shape of the

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resulting curve will give the required information, in accordance with the well known rules for combining simple harmonic motions. In the primary circuit of the transformer was interpolated a small solenoid, M, fig. 3. This solenoid or bobbin was mounted on guides, R_1, at right angles to the axis of the Braun tube, B. The condenser, consisting of the two metal plates, P_1 P_2 and an intervening vulcanite block, S_2, was mounted on guides, R_2, at right angles to the axis of the tube and also to the guides, R_1. The bobbin, M, produces a magnetic deflection of the cathode rays at right angles to the magnetic lines of force, and the condenser, P_1 P_2, produces a deflection in the direction of the electrostatic lines of force. These two deflecting forces, therefore, produce deflections at right angles to each other, and the bobbin and the condenser can be adjusted at such distances from the tube that the deflections are equal.

As the result of numerous experiments, Ebert found that the figures produced by the combination of these two perpendicular oscillations were invariably approximately circular ellipses. This showed that the phases of the oscillations differed by as nearly as possible a quarter period. Now we know that the phase difference between the primary and secondary of the transformer must in this case be quarter period, and it follows, therefore, that the oscillations of the cathode rays are in phase with the charging of the condenser and not with the magnetic field produced by the displacement currents.

Ebert has also shown, by calculation, that the deflection which would be produced by the magnetic field produced by the displacement currents would be only $\frac{1}{300000}$ of that actually observed.

It may be taken, therefore, as proved, that the oscillations of the cathode rays between the plates of a rapidly charged and discharged condenser are *not* due to the magnetic effect of the displacement currents.

II.—The Electrostatic Charges on the Walls of the Vacuum Tube.

It is well known that a vacuum tube in which cathode rays are being produced shows strong electric charges on its walls. In the Braun tube, which is somewhat different in shape from the ordinary Crookes tube, the distribution of the surface charges can be easily ascertained by a proof ball and an electroscope. The proof ball (of brass) is fixed on the end of a glass rod; different parts of the surface of the active tube are touched by the ball, and the charge on the ball is then tested by the electroscope. By exploring the surface of the Braun tube in this way, Ebert found a very strong negative charge on the cathode end of the tube, which covered the whole surface of the tube to about half way between K and A (fig. 1). The charge was so strong that sparks could be drawn from the surface of the tube, and the surface charge lasted for a considerable time after the discharge in the tube had stopped. The negative charge was gradually neutralised towards A, and before A was reached was replaced by a positive surface charge which, however, was not quite so strong. This positive charge continued in varying amount up to the diaphragm, D, reaching a minimum shortly before D was reached. In the cylindrical part of the tube behind the diaphragm, D, there was found a very strong positive charge, which increased steadily towards the end, S, and reached such an intensity on the surface of the pear-shaped end, that small sparks could be drawn off after the discharge in the tube had ceased. The positive charge outside the tube implies a corresponding negative charge on the inner surface of the tube. In the active Braun tube, therefore, all parts of the inner surface of the section D S, even where the cathode rays do not strike, are coated with a layer of positive electricity, which binds a corresponding negative charge outside.

By these surface charges the course of the cathode rays is essentially influenced. It is well known that the cathode stream always moves along the axis of the tube, even with considerable variations in the shape of the cathode; but if the surface distribution on the tube is disturbed by putting one part to earth, or by drawing off sparks, the beam of cathode rays jumps at first suddenly to one side, and then returns slowly to its original position. The return of the rays to the axis of the tube is evidently due to the restoration of the surface charges by the action of the tube.

The oscillating electric field will evidently have the effect of periodically changing this surface distribution, with the result of producing oscillations of the cathode stream, in the same way in which a single disturbance produces a temporary deflection. Some idea of the mechanism by which this deflection is produced may be obtained from what follows.

III.—The Influence of the Cathode Phenomena Called Into Existence by the Oscillating Electric Field.

Ebert and Wiedemann have shown* that when alternating electric tensions are applied to electrodes on the outer surface of a sufficiently evacuated tube, cathode rays, with all their attributes of dark space, &c., are produced opposite the electrodes inside the tube. It was found sometimes, however, that these phenomena could not be obtained, though all the essential conditions of the experiment appeared to have been fulfilled. Then it was discovered that the cathode phenomena could always be started again by sending a direct discharge through the tube from internal electrodes. From this it would appear that the cathode discharges produced by alternating potentials applied to external electrodes are only possible when there are considerable surface charges on the walls of the vacuum tube.

From what has been said above, it will be seen that these conditions exist in the Braun tube, as used in Schmidt's and Ebert's experiments. When the tube was examined in a dark room, sparks could be seen passing between the condenser plates and the sides of the tube, but no corresponding cathode discharges were observed inside the tube till after the main cathode discharge had taken place.

Ebert and Wiedemann have shown† that the dark space from one cathode offers a great resistance to the passage of rays from another cathode. They described one experiment, in which, by means of a movable cathode, the rays were brought gradually closer to the dark space of another cathode. As they were brought closer they failed completely to penetrate through, but became deflected and bent round the outline of the dark space.

These experimental results can now be applied to explain the oscillation of the cathode rays in the oscillating electric field. The electric oscillations proceeding from the condenser plates, will project a dark space into the interior of the tube, first from one side and then from the other. These alternately projected dark spaces bring about the observed oscillations in the main cathode beam. According to the experiments of Kaufmann and Aschkinass,‡ the deflection *ceteris paribus* is proportional to the potential gradient of the deflecting cathode. There must, therefore, with a regular periodic electric force, be an oscillation of the cathode rays obeying the sine law. And this is exactly what has been observed.

These interesting experiments of Ebert's appear to show that the deflection of the cathode rays in the oscillating field are not primarily due to the potential gradient of the electrostatic field but to a cathode discharge which is created by this gradient. Why the dark space should have this curious resistance to the passage of cathode rays remains unexplained, though it appears to be a well-established experimental fact. Ebert, indeed, with true scientific caution, does not consider that his experiments exclude the possibility of direct electrostatic influence, but only that such influence if it exists is too weak to be shown by the Braun's tube. These experiments, however, appear to be fatal to the view that the whole of the electric current is carried by the particles of the gas in the form of electric charges. They point rather to the view that the current inside a Crookes tube differs only in degree from what takes place when a current passes through a gas outside the tube.

Ebert points out that his apparatus, illustrated in fig. 3, forms a very convenient and sensitive arrangement for measuring the difference of phase between the primary and secondary currents in transformers, and recommends its use to electrical engineers.

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* *Wied. Ann.* 50, p. 42, 1893.
† *Sitzungsber. Physikal Societät Erlangen*, 24, p. 114, 1891.
‡ *Wied. Ann.*, 62, p. 588, 1897.

THE SECRET OF THE KEELY MOTOR.

Probably in no other civilised country in the world are the people more characterised by a mixture of shrewdness and credulity than most folks are in the United States. This perhaps accounts for the reason why he whom we have called quack, charlatan, and swindler, viz., the man Keely, has managed to keep alive the public interest for 25 years. We have dealt with the man and his pretensions on many occasions, and have not hesitated to state our opinion in the plainest of terms; we judged him by his works and his record, and there is no reason to alter our opinion. An opportunity of seeing the celebrated motor, and of testing its alleged performances was never presented to us, otherwise we doubt not we should have succeeded, as we have done in other instances, in showing that Keely was at best only a clever old juggler. He exhibited his greatest cleverness, however, in keeping his motor in his own workshop. We are not aware that during all the years that he was levying toll upon the purses of his enthusiastic admirers, he ever presented one of them with even a little model as a token of his affection and regard. He would invite them on to the platform, so to speak, and assure them there was no deception; but, of course, he could not be expected to give his bag of tricks away.

Keely is getting old now, and possibly, like the late Tichborne claimant, he is driven to earning a precarious dollar by getting himself interviewed, but has not now the cuteness necessary to recognise a skilled scientist in the garb of the newspaper man. At any rate, Keely has been interviewed by Mr. E. A. Scott, of the Philadelphia Engineers Club, and this "chiel taking notes" has also been taking observations, from which he concludes that the great magician's famous "apergy" seems to be only an ingenious combination of compressed air and electricity.

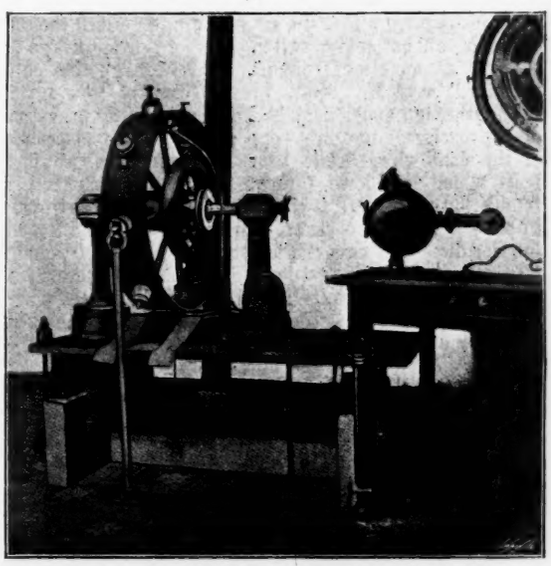
The results of the interview did not go to adorn the columns of a dime newspaper, though probably Keely thought that his interviewer was simply searching for copy (for the war had not broken out then), but were made the subject of a paper of considerable length, read before a meeting of the Engineers Club at Philadelphia.

Mr. Scott said the Keely motor has been a matter of greater or less public interest for 25 years, and yet there is now as little knowledge of what it is as when it was first announced. Probably no other enterprise making as little progress was ever kept alive so long. Keely has carefully guarded his secret; even the Courts could not extract it from him. In fact, the secret constituted the entire property, of which Mr. Keely was the treasurer, and even the company formed to exploit his supposed invention was never able to wrest it from him. Any effort on the part of the stockholders to do so has been met with the objection that Keely controlled the situation, and the value of their property depended on their keeping on good terms with him.

Many investigators, scientific and otherwise, have seen his experiments; United States Government officials and experts have witnessed them; capitalists, with millions at their disposal, have sought to control his inventions; yet there has always been an unreadiness on the part of the inventor to do anything practical. He is now over 70 years of age, and the possibility of his secret dying with him has aroused those who have supplied him with funds to the desirability of having him communicate his knowledge to someone who could continue his work.

Probably the idea of raising more money in this way originated with the man himself who, with one foot in the grave, still hopes to continue his success as an exploiter of public credulity.

The Keely motor or engine is the last of the long series of Keely's inventions, of which the previous apparatus are only experimental studies. It is supposed to embody the principles which Keely has laboured so many years to establish. He says it is operated directly by "apergy," a force hitherto unknown; that apergy consists, like light, in extremely rapid vibrations of ether, or matter of infinite divisibility which pervades the universe, the problem being to devise apparatus which will respond to these vibrations. This apparatus he calls the vibrodyne, which is thus described: A heavy cast-iron bed-plate, supported 18 inches above the floor by an iron slab at each end, bolted to the floor at each of the four corners by heavy iron rods and braced from the side walls, forms the foundation of a machine which can be prevented from running by the pressure of a finger, or stopped when at full speed by grasping it with one hand. A flat brass ring, about 4 feet in diameter, is supported on two wooden slabs resting upon the iron bed-plate, which are held to it by brass straps. On the outside of this ring, at equal distances apart, are fastened clusters of short tubes, each about a half inch in diameter and 3 inches long, called resonators. These tubes are partially filled with amalgam, or stopped up with diaphragms at varying distances from the ends. There are nine of these clusters on the circumference of the ring, and on the outside of each is a hollow binding post, to which wires can be attached. On the inside of the ring, immediately opposite the resonators, a "sensitised disc" is attached. On the inside of this disc is another binding post similar to the one outside the ring, which is also hollow, and making an open passage between the inside and the outside binding posts. There is thus a



The Vibrodyne or Keely Motor.

set of nine binding posts and discs pointing inwards, which are connected together by the mysterious platinum wire which figures in nearly all the experiments. The outside resonators and inside discs are about 2 inches apart.

Concentric with and inside of this ring is the revolving wheel. Its axis is supported at each end upon large iron pillars enlarged at the bearing of the axle. A large hub in the middle of the axle has radiating from it eight spokes, one less than the number of opposing discs on the inside of the flat ring. These spokes do not terminate in a rim, but on the end of each is a disc similar in size and character to those which project inward from the ring. There is also upon the axle near the hub a heavy iron ring about 14 inches in diameter, which revolves with it, presumably as a balance wheel to make a steady motion.

Keely set the wheel revolving in the following manner: Taking a 10-inch sympathetic negative transmitter (a large brass ball), he placed it on a table having a glass top, on one side of the room, and connected it with the vibrodyne by a platinum wire, attaching one wire to the binding post of the transmitter and the other to the binding post projecting from a resonator on the top of the vibrodyne. Then snapping some of the wires on the scale of the transmitter, and turning the handle backwards and forwards, the wheel commenced to revolve, slowly at first, and with gradually increasing speed, until the revolutions were about 180 per minute. Keely suggested that he could stop the wheel in several ways, two of which he illustrated. He pulled the wire out of the binding post of the transmitter, and it stopped. Again starting it, he stopped it by pulling out a plug in a hole in the binding post of the machine, the hole being a continuation of that hole into which the wire was thrust on the other side.

This left the transmitter attached to the machine, and gave Mr. Scott an opportunity to confirm his belief, formed from previous observations, that the so-called platinum was a small platinum tube. On the occasion of this experiment he took his seat next to the revolving wheel, not following Keely's suggestion to take another position. When Keely pulled out the plug from one arm of the binding post (which is in the form of a "T," and is hollow), leaving the wire sticking in the other arm, the other end of the wire still being connected with the sympathetic negative transmitter, he moved his face close to the hole left by the plug being removed, and distinctly felt a blast of air from the "wire." To make certain that the air current did not come from the revolving spokes, he kept his face in the same position until the wheel had stopped, and still felt the full force of the blast of air from the tube. Here was a confirmation of his belief that the wire was a tube carrying compressed air, the reservoir of which was the 10-inch globe of the "sympathetic negative transmitter." It was evident, however, that a sufficient amount of power to run the wheel for any length of time, or to run it at all, could not be stored in a globe of that size. His conclusion was that the air pressure performed the office either of an automatic switch closer or an automatic pole changer on an electric circuit. "The construction of the machine," says Mr. Scott, "points directly to electricity acting through magnetism." The unnecessarily heavy parts of the machine afford every opportunity for the concealment of the small wires necessary for the power developed, or the bolts which run down through the floor to hold the iron foundation could serve as conductors. It was an easy matter to bring a current to electro-magnets concealed in the nine interior discs, and no great amount of ingenuity would be required to construct a switch, operated upon both by the compressed air and magnetism, which would cut the magnet into or out of circuit at the proper time to attract the armature on the end of each revolving spoke. Had there been nine spokes as well as nine opposing discs, the wheel would have got on a dead centre, and could not have always been started; but with only eight spokes there were always some in a position to receive a magnetic pull before the magnets were cut out of circuit by the opposing discs being exactly opposite each other. The evidence of design here is sufficiently strong to warrant the conclusion that the wheel is operated by electro-magnets. "Apergy" would not have required this arrangement.

Mr. Scott declared that some of the most important of the experiments had since been duplicated by very simple means, which may have been the very means used by Keely. One of these was the well-known levitation experiment, by which, apparently, heavy weights are made to float in water. It was explained that the weights in the jar might be so constructed as to just sink in the normal condition of the jar, and to rise when a slight increase of air pressure was put upon the surface through a fine tube carrying compressed air, after the principle of the "Cartesian diver." This tube, called a platinum wire by Keely, was said to form an essential part of most of his apparatus.

Mr. Scott's conclusions from his personal investigations are in substance precisely the same as those to which we have always arrived, viz., that the man Keely cannot substantiate his claim to have discovered any hitherto unknown natural force, but that he is a juggler of superior ability.

OIL FUEL FOR STEAM RAISING.

A GREAT deal has been said and written in favour of water-tube boilers in particular, and boilers of small water capacity in general, with special regard to rapid steam raising, not so much on the score of rapid steam production from cold water, but when a boiler is at work, on rapid increased production. Many who argue on the point do so entirely without thought. Assuming that the boiler is worked at a temperature of 300°, if the fire becomes more fierce there is more steam made, and if the safety valve is of proper size, the temperature of the boiler does not rise above 300°. If no rise in temperature takes place, the amount of heat in the water does not become greater. Therefore, all the additional heat of the fiercer fires has been applied in furnishing latent heat to water at 300° to convert it into steam at 300°. We see no way out of this conclusion. No heat has entered the water, for had it done so the water would be hotter, and, being so, the steam would rise in pressure. Our conclusion being inevitable, it must follow that whether the boiler contains 5 tons of water or 15 there can be no difference in the rapidity with which it will answer to a pushed fire. With engines working with 300° steam the addition suddenly of other similar units makes a demand for more steam at 300°, not for steam at 310° or 315°. If steam at a higher temperature were called for, there would be more rapid reply to a pushed fire by that boiler whose steam space was least or whose water content was least. This plain fact is quite overlooked by those to claim rapid reply to calls on behalf of boilers of small water capacity. In one respect only does a large capacity tell against a boiler, and that is where the circulation is poor, part of the water lies dead and cold in the boiler bottom, and a sudden livening up sets this water in circulation and checks the steam production instanter. But this is a fault which ought to be otherwise remedied, as, for example, by a pump to transfer the surface water to the boiler bottom continuously, a system absorbing very little power, as the pump would work in a closed circuit and have no tight pistons, or it might be a centrifugal one.

Apart from faulty circulation, the cry for little water content in a boiler required to give sudden demands is erroneous and essentially unscientific, and based on entirely false assumptions. The same additional heat will form the same amount of steam, no matter what the water or steam capacity, so long as the feed water is supplied at the same temperature in each case.

Where sudden calls for steam are made, there is wanted a fire that will quickly respond to an increased demand as signified by a wider damper opening or an increased fan speed. No solid fuel fire can immediately rise to the call made suddenly, and a sudden demand for steam must almost invariably be first met by a reduction of pressure which allows the water in the boiler to give up some of its heat by lowering its temperature. Here, then, we see the advantage of large water capacity, and an ability to give off considerable heat without too great a fall of pressure. But what is really needed is a sudden accession of fire. With a boiler at 300°, a sudden addition to the fire would give an almost instantaneous addition to the steam supply.

The problem thus narrows itself down to a means of securing the necessary increase of the fire. This must not be done at too serious an expense of costly fuel, nor can it be done at all with solid fuel, except in the shape of air-carried dust. A careful consideration of all the conditions involved, points strongly to liquid fuel as the auxiliary. Liquid fuel can be blown into an ordinary coal burning furnace without any change being made in the furnace conditions. Take Holden's system as an example. In this system a locomotive has two holes in the fire-box, through which the oil fuel is blown by compressed air in a fine spray upon the fuel on the grate. Only a light fire of coal and chalk is carried; but if desired, a heavy fire could be carried, and merely supplemented on gradients by a temporary admission of oil. We have travelled on one of Mr. Holden's oil burning locomotives with a heavy train behind, and were astonished at the ease with which the fuel supply could be regulated to suit the demand for steam, and at the way in which, at a stopping station, the oil was shut off completely, and at once re-started at exactly the previously existing rate of flow, when we moved out again.

For general power purposes, the one question is that of expense. To the central electric station engineer the demand for steam is foreseen from hour to hour the year through. The load curve, combined with a weather observation, is sufficient for estimating the proper time to get fires ready to spring into activity in time for the big demand. But in the English climate, and particularly in the peculiar situation of London, sudden unforeseen obscurations of the sun are apt to occur, with little or no warning. Under these circumstances a single movement of a lever would fill the furnaces with brilliant flame and increase steam production to a maximum. In the Holden system, oil is injected by means of a peculiar nozzle, consisting of a central mixed jet of air and oil impelled by steam, and surrounded by a ring pierced with small holes, through which steam issues, and induces a

good air supply to burn the pulverised oil as it is diffused over the fire-box and the fuel on the bars.

Approximately, 1 lb. of liquid fuel will do the work of 2 lbs. of coal, and this figure can be used in conjunction with the relative prices of coal and "oil" in determining the cost of oil fuel. The cost of oil will often be prohibitive; it would soon become prohibitive if everyone took up its use, but, for sudden demands, its cost is well worth incurring for a few minutes to get over the peak of a load curve with otherwise insufficient boilers, or to get matters in order when a fog or a thunderstorm sends up the demand for current. Current demand falls off nearly as rapidly as it rises; with solid fuel the drop in demand may find furnaces full of fuel and in full swing; with oil fuel the *régime* of the furnace can be restored instantly, and further expense at once stayed.

We are confident that station engineers who undertake to try liquid fuel, say, in one boiler, will appreciate its convenience and the aid it will afford them. Liquid fuel is easy to apply, the apparatus required is small, and it need not interfere with the ordinary arrangements of a boiler. Indeed, in the Holden system, either liquid or solid fuel can be used at will. The operation of changing from one to the other may be said to consist simply in the picking up or throwing down of the coal shovel, and the opening or closing of a valve. The elasticity is perfect.

BATTERIES v. GENERATORS.

In a young industry like electricity supply, a large amount of energy has to be expended in educating the public to the adoption and use of electricity for domestic and other purposes. This accomplished, attention is turned to the best means of supplying the want which has been created.

The question of pounds, shillings and pence, enters largely into the calculations, in fact, it is the controlling factor, on it hinges everything. Before expending capital a reasonable prospect must be visible of receiving an adequate yearly profit, or great difficulty would be experienced in raising the necessary money to erect electricity supply stations.

The electrical engineer has devised various means and systems of supplying electricity for various purposes, and naturally these are all based on the economical generation and distribution of electricity, and rightly so.

Engines, boilers, generators, transformers, mains, lamps, &c., are all chosen with the above considerations well in view, and the result has been an ever-increasing and important industry has sprung up, affecting the whole community, the importance of which cannot be over-estimated.

The general demand for electricity keeps on increasing in every city and town where a supply has been established, and the little station of a year or two ago, put down as a "feeler" as it were, has grown to be an important concern which bids fair to rival, if not eliminate, the local gas industry.

This at present, to the sceptical, may seem impossible and absurd, but where do we find a customer who has once experienced and appreciated the comfort, cleanliness, and safety of the electric light, expressing a wish to go back to gas with its dirt, danger of fire, explosion, and asphyxia? The rush light was superseded by the candle, the candle by the oil lamp, the oil lamp by gas, and now a greater power in the land than even gas has appeared.

Just as each of the new means of illumination was more expensive at its introduction, until the demand and supply regulated the price and brought it to its proper level, and its increased advantages and better illumination slowly but surely gained for it the preference, so each of the older means of illumination will gradually die a natural death, but not without a struggle. Many were the blows aimed at the new comer, but it has come to stay. It is only a matter of time, and we believe a very short time, until the prejudices of to-day, many of them interested prejudices, will have disappeared, for the simple reason that no opposite interests will exist, or if they do their feeble attempts at depreciation will be treated with scorn by the majority of those who at present side with them, for by that time they will be using the new illuminant and will have learned to appreciate and rely on it.

It is the question of "reliance" which we wish to emphasise. Various means are adopted to ensure a constant and uninterrupted supply. Spare plant in the shape of engines, boilers, generators, transformers, accumulators, &c., are all in use to-day for this purpose, but who can truthfully say we have any reserve?

In cases of emergency, valuable time is lost in "getting away" with the spare plant; and if continuity is preserved at least pressure is often sacrificed. No matter how well it looks on paper to have a certain proportion of spare plant to take up the work in case of accident, we know that time must elapse before a stand-by boiler can be got up to proper working pressure, or an engine run up to full speed and put on to the work, and we also know that the expedition and precision with which these are done depends largely on the intelligence, experience, and coolness of the men on duty. The motives of economy which govern all electricity works throughout the country render a number of *spare men* an impossibility. In times of peace the men on duty have, especially during the the period of greatest demand, their hands full, but when things begin to go wrong and attention is diverted from the running plant to getting under way the spare plant, many a threatened calamity has become only too real by the insufficiency of men at these critical moments.

The vulnerable spot, which is well known to electricity's enemies, is no doubt a danger of sudden extinction. Although they are becoming fewer and fewer, and when they do occur their duration is briefer, yet their seriousness does not diminish but rather increases, for the danger is not removed. The important question which will shortly have to be faced is: Shall we continue to depend for a stand-by on spare units of plant, or shall we tackle the storage battery question in a proper spirit and have a reserve of electricity which will make us quite as independent of temporary disarrangements of machinery as gas suppliers? We say gas works store gas because they cannot make it as it is wanted, and we generate electricity because we can make it as it is wanted, and because it is more economical so to make it, and because we cannot store it in sufficient quantities to be of much use as a reserve. What evidence have we to support this latter assertion?

Electricity is undoubtedly generated cheapest when the machinery is working at full load, but this comes for such a short time each day that a great many makers of late years have been designing their plant to give best results at or about three-quarters load, because they are called upon to work under these conditions many more hours in a given time. The hours of heavy load each day are very short indeed, the peak seldom lasting more than 20 minutes to half-an-hour, yet we have to keep plant to supply current and maintain the proper voltage over the system at this time, and in addition have in reserve a reasonable amount of spare machinery.

If the output of a year was averaged over the 24 hours of the day for the 365 days, it would be found that the current could have been generated by an astonishingly small unit of plant; probably one of the station exciter engines and exciters would have been ample. It would certainly seem that if ever complete reliance can be placed on electrical supply, storage batteries must enter more largely into the composition of supply stations than at present. The installations of accumulators to be met with in various stations presumably kept as a reserve in case of need, but principally to supply the current in the hours of minumum demand, are a delusion. They are only toys compared with what they should be. If occasion arises when an unusual demand has to be put upon them they fail utterly.

Consider for a moment a station equipped mainly of huge storage batteries composed of plates nearer the size of billiard table tops than the cover of a pocket note book and we get something like a battery. As mentioned above, if the year's demand was spread out evenly over the 8,740 hours in a year of 365 days we begin to realise what a small sum would have to be spent in generating machinery. The small plant would be worked day and night in charging the huge accumulators, and as they would be working at or nearly full load the current would be generated as cheaply as possible, and this would tend to lessen the loss in efficiency in the batteries as we at present know them.

When we remember that the commercial efficiency of a battery is somewhere between 50 and 60 per cent., although the makers place it as high as 75 per cent., it is not so very far behind the commercial efficiency of a modern plant working under ordinary conditions. Coal is the largest item in out-of-pocket expense in the production, and it often happens that this item in a summer month is three times as much as in a winter month per B.T.U. generated; when this is borne in mind, the apparently wide gulf between the two systems narrows perceptibly.

A large amount of running plant requires an extensive and efficient staff, generally multiplied by three to cover the 24 hours of the day. By the storage system the wages bill would be cut down at least one-half, if not more. Wages form the largest of establishment charges, and with one-half abolished we witness a still further reduction in the great gulf fixed. Maintenance and depreciation affects both systems. No doubt the heavy charges of present batteries is largely due to having from time to time to work them under unnatural conditions. Sudden heavy overloadings do not tend to improve them, and if often repeated do great harm.

If batteries amply large are in use, then overloading should never, or very rarely, occur, and this alone would tend to lengthen the life.

Battery suppliers will gladly enter into a maintenance contract for a number of years from 7½ per cent. upwards on the original cost, making good all deterioration due to fair wear and tear.

We usually put aside 5 per cent. on the cost price of our machinery for depreciation, but this sum does not cover maintenance, which will not come far short of another 2½ per cent. Where, then, is the difference if the two systems cost the same money to instal? If the battery system costs more, should we not gladly pay more to ensure absolute immunity from interruptions in the supply from the generating station.

Interruptions from causes exterior to the generating station must be dealt with in precisely the same manner, and do not enter into the question.

Accumulators are engaging the attention of engineers at present, due, no doubt, to the prospect of motor-car traffic developing, and the efficiency and mechanical strength will increase, while the depreciation and maintenance figures will diminish.

THE ECONOMICAL USE OF STEAM IN NON-CONDENSING ENGINES.

For many years the technical papers were full of the beauties of automatic and variable expansion gear, and the advantages of the steam engine indicator. We seem likely now to be equally supplied with papers rubbing out the arguments so long advanced. The *Engineering Magazine* contains one from the pen of Mr. Jas. B. Stanwood, advocating the throttle governor for non-condensing compound engines. He quotes Mr. C. T. Porter as saying that nothing so unsuitable as the automatic variable gear could have been devised if it had not been already in use.

The range of economical working of an engine is much wider than expansion faddists would once allow. Men who swore by the indicator now find it better to pay more attention to the relation of indicated to effective horse-power, and are learning to pay attention to the internal friction of large engines which so soon puts a limit upon the desirable expansion ratio, especially when taken in combination with various other losses, such as initial condensation and interest on first cost. Mr. Stanwood realises that Corliss—and he might have added pre-Corliss English inventors—effected a big economy not because of variable cut-off but because they abolished ridiculously late cut-off, and made a valve gear capable of cutting off at about a quarter stroke. The variability was with Corliss a mere accident. It could have been well dispensed with so long as a fair cut-off was secured, any load variation being dealt with by the throttle. Had Corliss been compelled to run his engines at light loads demanding cut-off at an eighth or a tenth, he would have seen the error of variable cut-off, for the full effects of cylinder action and waste spaces would have been more apparent, and the low mean pressure compared with the friction diagram would have made the fuel cost per effective horse-power very serious. The terminal pressure would have been only 5 or 6 lbs. below atmosphere, the piston being dragged against the atmosphere. Sometimes this occurred, and disappointment followed the use of too large engines. In old style transmissions with so very much shafting and belts to move, there was always a heavy dead load on an engine, and the ratio of light load to full load was not so far from unity as with a dynamo engine which may vary from full load to a mere engine friction load, and these light loads could not be operated economically with expansion gear, the limit of expansion being soon reached, varying, however, with the type of engine—being shorter with short stroke engines. High speed engines of short stroke were found to be more economical than similar engines at slow speeds of revolution. Engines with small clearances were similarly found to have superior economy. Long stroke engines had an economical expansion of four, some short stroke engines of only two. Thus the economic early limit of expansion was respectively five and three in the two types, the reasons being those of clearance space and condensation in the cylinder. Clearance is ordinarily 3 to 4 per cent. in long stroke engines, but has been reduced to 1 per cent. in special cases. In short stroke engines it is 15 or 16 per cent.—hence the advantage of long stroke engines, for filling up clearance of compression by no means give back the loss.

Mr. Stanwood says nothing of the importance of careful design on cylinder condensation effects. There are a dozen ways in which a nominal equality of inside exposed surface may be trebled or quadrupled by careless design. On this point a report by Mr. M. Longridge may be studied with interest.

Increase of steam pressure has intensified all the losses due to clearance, and no doubt this has done so much to counterbalance the gains due to high pressure *per se*. High pressure means more weight of steam to fill up clearance space, and it means wider range of temperature and more condensation. But high pressure enables a higher minimum pressure to be carried and reduces the expansion below atmospheric pressure. Gain from high pressure could only be secured by the compound system, but this had its limits exactly as had the single cylinder, and, unless with full loads, the non-condensing compound automatic engine was a failure and economy was found to be possible only for nearly constant loads. It has always been recognised by practical engineers to be a mistake to drag round a huge L.P. piston on a semi-loaded engine. In compound engines, non-condensing, the loss due to excessive expansion below the atmosphere is even greater than in simple engines. With increase of pressure the difficulty increases, because the minimum mean effective pressure obtainable without expansion below the atmosphere increases with the pressure, and at about the same rate as the maximum mean effective pressure. Hence the ratio of the minimum to maximum mean effective pressure is not reduced for light and heavy loads as in the simple engine. Where both cylinders are controlled by the governor this drag develops in the H.P. cylinder whenever its terminal pressure falls below the high receiver pressure induced by early L.P. cut-off. Control of both cylinders involves large clearance spaces to avoid stresses due to high compression. Experience seems to point to the desirableness of not controlling the L.P. cut-off by the governor but of fixing it at about $\frac{7}{16}$ths stroke, and regulating in the H.P. cylinder only. Mr. Stanwood, however, would control both cylinders and reduce clearance losses by suitable compression and by avoiding early cut-off. Obviously the compound engine must have only a moderate expansion in each cylinder, otherwise cylinder condensation and clearance losses are brought about, and the non-condensing compound engine is only economical at uniform load and when properly proportioned to such load.

Taking into consideration all the difficulties and data, our author advocates fixed cut-off to determine full-load and throttling governing, and proposes to more fully discuss the subject in a second paper.

THE HEFNER LAMP.

In order to express measurements of light so that the results are strictly comparable with each other, all light intensities must be expressed as a multiple of a fixed unit. For technical purposes the only units available are flames, since these alone are cheap, always reproducible, and handy to use.

As the result of the investigations of the German Reichsanstalt, the Hefner lamp alone fulfils all technical requirements. The light of the Hefner lamp is designated a *Hefner candle* or simply *a candle* (H K). The definition of a Hefner candle and Hefner lamp is as follows:—

The unit of light is the light intensity of a flame burning freely in still, pure atmospheric air; the flame being produced from a massive wick saturated with amylacetate which completely fills a circular wick tube of German silver, 8 mm. internal diameter, and 8·3 mm. external diameter, and 25 mm. long; the height of the flame being 40 mm. from the edge of the wick tube, and no measurements being made till at least 10 minutes after the lamp has been lighted.

The Hefner candle was accepted as the international unit of light by the Electrical Congress at Geneva in 1896. In Germany this unit has been adopted by the societies representing the electrical and gas industries.

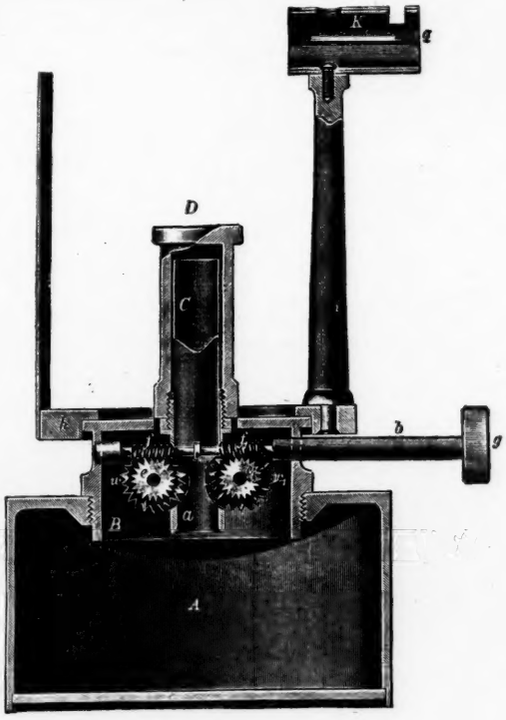


Fig. 1.—The Hefner Lamp.

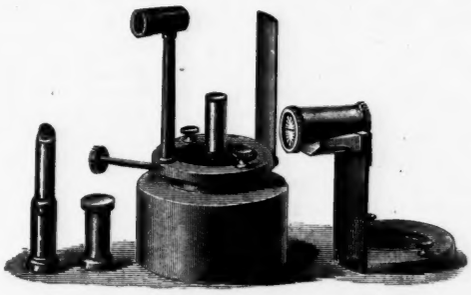
The light intensity of the Hefner lamp varies to a certain extent with the condition of the surrounding air. The influence of the height of the barometer and humidity is shown by the diagrams, figs. 3 and 4. In the neighbourhood of the normal barometric pressure, the variation of the light is of no practical importance. The variation of the light-intensity with change of humidity is also of little practical importance. On the other hand the intensity of the light is very much influenced by the amount of oxygen in the air in which the flame is burning.

One of the first conditions, therefore, for accurate photometry by means of the Hefner lamp is that the space in which the lamp is used shall be sufficiently large and sufficiently well ventilated.

The following is a description of the Hefner lamp as manufactured by Siemens & Halske, which is shown in section in fig. 1.

The reservoir, A, for the reception of amylacetate is made of brass or bronze and is tinned inside.

The cap, B, supports at its centre the tube *a*, and the mechanism for raising and lowering the wick. This wick mechanism consists of two axes, on which are mounted two toothed rollers, *w* and w^1, projecting through the sides of the tube. Fixed on the axes of the rollers are two toothed wheels, *e* and e^1, which can be turned in opposite directions by a pair of endless screws, *f* f^1, mounted on the same axis, *b*. This axis, *b*, terminates in a milled head, *g*, with the help of which the wick mechanism can be set in motion. The tube, *a*, projects above the upper plate of the cap, B, about 4 mm., and on this projecting end a screw thread is

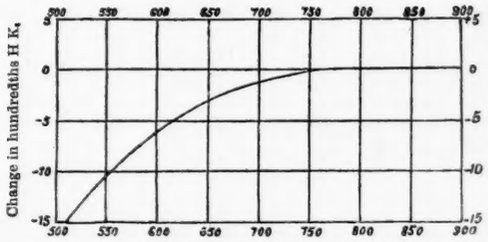


Gauge. Hefner lamp with Hefner flame measurer. Krüss flame measurer.

Fig. 2.

formed on which the tubular cover, D, can be screwed. Close to the tube, *a*, there are two openings in the top plate of the cap, to admit air to take the place of the liquid consumed.

The wick tube, C, is made of German silver without a soldered joint; its length is 35 mm., its internal diameter

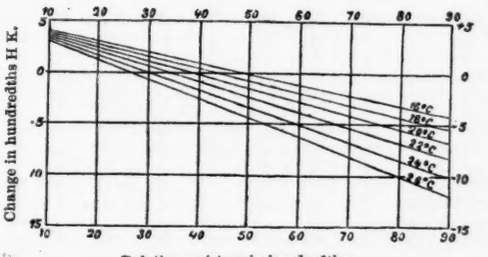


Change of light intensity of the Hefner lamp with the height of the barometer.

Fig. 3.

8 mm., and the thickness of its walls 0·15 mm. It is pushed down into the tube, *a*, till it comes against a shoulder.

The flame measuring apparatus for determining the length (40 mm.) of the flame, is mounted in a ring, *h*, which in



Relative moisture in hundredths.

Change of light intensity of the Hefner lamp with relative moisture at different temperatures.

Fig. 4.

turn is mounted on the top plate of the cap B, so that it can be lifted off or turned round and fixed in any position.

The apparatus of von Hefner-Alteneck or of Krüss (fig. 2) may be used for measuring the flame. The Hefner flame measurer (figs. 1 and 2) consists of two pieces of tube, one pushed inside the other, and fixed so that their horizontal

axis passes through the vertical axis of the wick tube. The inner tube is cut in two longitudinally, and supports horizontally a polished steel plate of 0·2 mm thick, with a rectangular opening. The under side of the steel plate is 40 mm. above the upper end of the wick tube.

The Krüss flame measurer (fig. 2) consists of a tube about 30 mm. in length, of which the axis is also horizontal and passes through the axis of the wick tube. A small lens of about 15 mm. focal length is fixed in the end of the tube next the flame, and at the opposite end is mounted a disc of ground glass with its ground surface next the lens. At the centre of the disc is a black horizontal mark not more than 0·2 mm. thick. The image of this mark over the centre of the wick tube is 40 mm. above the top of the tube.

The gauge (fig. 2) serves to fix the position of the upper end of the wick tube, as well as that of the flame measurer. If the gauge is pushed over the wick tube so as to rest upon the cover of the cap B, then by looking through a slit in the tube, a line of light less than 0·1 mm. will be seen above the end of the wick tube when the latter is at the normal height; the slit at the top of the gauge should lie in the same plane as the steel plate of the Hefner measurer. With the Krüss arrangement, the image of the slit on the top of the gauge should coincide with the mark on the ground glass.

All the metal parts of the lamp, except the wick tube and the steel plate, are etched to a dull black colour.

THE BRITISH ELECTRIC TRACTION COMPANY.

On Thursday evening, the 26th ult., the staff dinner of the British Electric Traction Company, Limited, was held at the Trocadero Restaurant, Mr. Emile Garcke, managing director, being in the chair. Amongst the company, which numbered about 45, we noticed Mr. Godfray, Sir Edward Gourley, M.P., Mr. George Herring, Sir Ch. Rivers Wilson, C.B., Major Cardew, R.E., Sir Charles Freemantle, K.C.B., Mr. Atherley Jones, Q.C., M.P., Mr. Sidney Morse, Mr. Alfred Dickinson, Mr. George Flett, Mr. H. Hatchett, Mr. R. Simpson, Mr. W. Alderson Smith, Mr. Percy Sellon, Mr. J. S. Raworth, Mr. W. B. Jeffries, Mr. A. R. Monks, Mr. W. H. Scott, Mr. J. W. Alison, Mr. B. Gibson, and Mr. H. F. Woodward.

The dinner was a thoroughly enjoyable one, worthy of the occasion and a credit to the caterers, and it was pleasant to observe the mutual confidence which exists between Mr. Garcke and his able staff, a confidence which we may be permitted to hope will continue for many years to come to the advantage of not only employers and employed, but to the benefit of the travelling public. The principal toast was that of "The British Electric Traction Company," proposed by the chairman, in which he said:—

In proposing this toast, I would prefer, of course, to be able to afford you entertainment, instead of speaking of the affairs of the company, which are already too fully engrossing the attention of most of you, but the circumstances of our gathering are somewhat exceptional. Several members of the staff have only lately either joined the company, or entered upon their present duties, and there are several gentlemen present who are connected with our associated companies. It has been suggested to me that they would like some fuller information than we have yet had the opportunity of giving them as to the policy and business of the company.

The extensive character of the business will be seen from the large number of undertakings which we have already under our control, to say nothing of those which are in course of being established or promoted, and its complex nature will be at once appreciated when I explain that we not only arrange for the acquisition or leasing of existing tramways undertakings, but also undertake the initial promotion of new schemes, with a view to working by electric traction. This, I need not say, is a work requiring a great deal of judgment and discrimination. It involves difficult and weary negotiations with the local authorities, and applications to the Board of Trade, to Parliament, and to the Light Railway Commissioners for the necessary powers. When these have been obtained the work of construction has to be undertaken, and when the line is ready to be opened for traffic, a totally different kind of talent and experience is required for carrying on the business. A large number of men have to be engaged, and traffic arrangements have to be carried out which require a very close study of local conditions.

It will be seen, therefore, that the operations carried on by this company require, in their various stages, abilities and experience which it is impossible to combine in any one individual. Moreover, our various undertakings are scattered over the entire length and breadth of the United Kingdom, and are not continuous, like railways, but are divided, at any rate at present, into relatively small sections.

Having regard to the multifarious duties to be performed, the board have come to the conclusion that the highest efficiency and the greatest economy in the conduct of so extensive an enterprise can only be attained by a carefully arranged system of devolution, combined with a scheme providing for watchful supervision of details. This the board believe they have secured by a specialisation of duties, and by the appointment of district superintendents, very much on the lines adopted by the large railway companies.

For instance, the board have appointed a permanent way engineer, who will attend to nothing but the permanent way of the various undertakings of the company wherever they may be located. The tramways, which in one form or another we control, cover between 80 and 90 miles, and the tramways for which we have already obtained powers, and which have to be constructed within periods specified in the orders, cover another 60 odd miles, and this does not include any of the new lines we intend to promote.

Then we have a traffic superintendent whose duty will be to establish, as far as possible, uniform traffic arrangements. We estimate that when our present tramway undertakings are electrically equipped we shall have at least 500 or 600 cars running, and shall directly or indirectly employ upwards of 2,000 men.

Then we have a power engineer whose duty is to superintend the construction and the maintenance of the electrical machinery. We estimate that when the tramways to which we are already committed are in full working order, we shall either have to generate or purchase upwards of (10,000,000) 10 million Board of Trade units of electricity per annum.

We have created a department for carrying on the responsible work of promoting and obtaining powers from Parliament, the Board of Trade, and the Light Railway Commissioners. The undertakings in regard to which we have made definite agreements for the adoption of electric traction are governed by no less than 60 Acts of Parliament or provisional orders, and the negotiations we have to carry on with the local authorities and other bodies involve a thorough knowledge of the provisions of all these Acts and orders. In addition to these we have at the present time some 15 or 16 light railway orders in progress, and have made agreements for the promotion of about 20 further Acts of Parliament, provisional orders or light railway orders. That is as far as we can see to-day, but we are not standing still, and are negotiating fresh business from day to day.

There are several other departments, but those I have mentioned are sufficient to show the principles which have guided the board in the distribution of the duties. So much for the technical staff. Now I will say a word or two as to the geographical divisions. We have grouped our various undertakings into districts with a superintendent for each district, who will be officially associated as a director, or in some other suitable capacity, with the undertakings in his district, and he will be in direct communication through the secretary with the heads of the technical departments. In this way each undertaking or company will obtain the benefit of the best expert advice and of a wide experience at only a small proportionate cost.

The geographical divisions we have decided upon have been determined mainly by the large centres of population in which our present business is chiefly concentrated.

By-the-bye, it will be of interest to state that our Kidderminster line was opened for traffic to-day, and this little line constitutes an exemplification of British electric traction in the truest sense of the word, for all the plant and rolling stock has been manufactured in this country by our friends the Brush Company. This is, I believe, the first electric tramway in this country of which this can be said.

From what I have said you will see that we are engaged in developing an extensive and important business, and it will be satisfactory to our financial friends to know that in nearly all the undertakings we are engaged upon, the expectations of earning dividends upon the capital to be invested are not based merely upon the faith that we have in the future of electric traction. In nearly all cases we have based our calculations upon the results obtained by the companies whose lines we are converting; and we all know that if a company working an inadequate service, by steam or by horses, is making a profit, we are certain to show better results when we put upon the lines a more frequent service at a lower cost of working. I may add that the capital we have employed in building up this business is already productive of profits, and, contrary to the Ricardian law of diminishing returns, every addition to our capital is calculated to produce an increasing margin of profit over the fixed interest we have to pay.

Sir Rivers Wilson, at the annual general meeting of the shareholders, referred to the subject of municipalisation of the tramways—a question which, I think, is surrounded by a good deal of misapprehension on the part of local authorities, who do not seem to realise the great difference between the municipalisation of horse tramways, which are generally confined within the limits of municipal areas, and electrical tramways or light railways, which, to attain their highest development and fullest utility, should be constructed with a view to connecting outlying towns and villages with the cities.

Sir Rivers Wilson struck the key-note of the matter when he said that municipal boundaries do not coincide always with the centres of population, and if the municipalities construct tramways, they have to confine themselves to their own boundaries, so that the outlying villages and towns are not reached, and it is because electric traction is particularly suitable for the working of tramways extending over long distances that electric traction is not a suitable industry for municipalisation.

No one would dream for a moment of municipalising our large railway systems, and the arguments against the municipalisation of railways, telegraph and similar enterprises, which pass from the area of one municipality to another, apply will equal force against the

municipalisation of electric tramways. The present tendency of Corporations to undertake the working of tramways will have the serious effect of retarding and restricting the natural growth of an industry, which, if not thus hampered, will, I am sure, extend as it has done in other countries in every direction, and contribute very largely to the convenience and welfare of hundreds of thousands of people who have to travel from one town to another, and to intervening places. If the policy of municipalisation of electric tramways advances, most of the smaller outlying places will be deprived of tramway facilities.

Not only the theoretical arguments, but the physical facts of the case demonstrate that the working of electrical tramways by municipalities will prove a social calamity. I am in sympathy on political and social grounds with the expansion of the sphere and scope of municipal life, and I am not at all averse to the municipalisation of undertakings which are confined within the limits of the municipal area, and which do not raise such large social questions as is the case with electrical tramways.

I have often spoken and written in favour of the municipalisation of electric light undertakings, but it is a question whether even this policy has not been carried too far. There are many small municipalities in the country which are not large enough to enable electric lighting business to be carried on with the greatest possible economy, and it is found now that electricity can be supplied more cheaply if generated on a large scale at a central point and distributed to these small authorities in bulk, but the fact of a local authority having established its electric light station is not the same thing as if it had been done by a company. In the case of a company making a mistake the unfortunate shareholders are inevitably brought face to face with a liquidation, and the competition of new comers leads to the survival of the fittest, but when a local authority is carrying on a relatively unprofitable business, this beneficial and effective competition is impossible because the local authorities have the power to prevent the larger and better supplier coming into competition with them.

In this way we see that the municipalisation of some undertakings stands in the way of industrial progress, and the advantages obtained from the working by municipalities, whatever those advantages may be, cannot be such as to compensate for these evils.

Now, let me refer to one or two of the physical obstacles which I venture to say municipalities cannot and will not overcome.

The difficulty of the variation of gauges in towns adjacent to each other has already been pointed out, but it is not generally recognised how widespread this anomaly is.

Which of these local authorities will make the gauge throughout the district uniform for the benefit of the others?

In our South Staffordshire scheme we proposed to alter the Wolverhampton gauge so as to bring it into conformity with the other tramways of the district.

I ask anyone will the Corporations—can the Corporations—do what the companies can and will do in the matter?

But the difficulty of municipalising electrical tramways are not confined to Corporations with small areas.

If the principal of municipalisation is sound, Manchester surely should demonstrate it. But what do we find there. Very nearly half the lines worked by the Manchester Carriage Company are outside the municipal boundary.

Among the suggestions made by the Manchester Corporation to the other authorities is one that each authority shall fix the fares in its own district. Now, this suggestion alone destroys the whole advantage to be derived from the control by one central authority.

Another suggestion is, that the several local authorities shall provide the necessary energy and electrical equipment for the working of the tramways within their districts. It is impossible to see what advantage so chaotic an arrangement of working such a large system would have over the uniform arrangements which a company working the whole of the lines would be able to organise.

I must not weary you by discussing all the other aspects of this question, but it will become our duty to face the problem before long, and we shall have to be prepared to expose all the other fallacies upon which local authorities are proceeding in this matter. If local authorities are not put right, we shall be responsible, because we have studied the question, and know the real facts. For my own part, I shall be prepared to contest the arguments advanced by those who favour municipalisation. I shall be prepared to show that the oft-quoted cases of municipal working do not support this doctrine. Then we are told that in the case of municipal tramways the profits go back to the ratepayers. Yes, but not to the same ratepayers who have produced the profits. I have been told by the mayor of a town in the North that about one-third of the total rates are paid by the railway company whose lines pass through the town. What comfort is it to the labourer in that town to know that by patronising corporation tramways he will produce profits, one-third of which will go to reduce the rates paid by the railway company?

Then we are told that corporations can borrow money more cheaply than companies; but this resolves itself merely into a question of tenure. If you give a company a tenure of 62 or 90 years, the slight financial advantage in favour of municipal loans disappears. Moreover, the grant of a longer tenure would have the enormous advantage to the community of enabling sparsely populated districts to be developed. The present system of granting concessions for only one-life period necessitating, as it does, a heavy sinking fund, precludes the possibility of either corporation or companies doing what has been done on so large a scale in the States—putting down electric tramways in anticipation of, and to encourage the growth of cities and industries.

But I have said enough to show that the subject deserves further discussion, and I only wish, in conclusion, to again emphasise that I have been prompted in what I have said on this subject of municipalisation, not so much by the immediate interests of the British Electric Traction Company, but by the feeling that, besides doing the work which lies before us, we have also the duty and the responsibility of promoting the general advance of electric traction. The work we have to do will offer scope enough for our energies and our ambition, it is a useful work, and I may say a noble work, which it is our intention to do, not only with profit to our shareholders, which, of course, is our first duty, but also with satisfaction to the public and with pleasure and advantage, combined with credit and honour, to ourselves. I propose to you success to the British Electric Traction Company, and health to Sir Ch. Rivers Wilson, our chairman.

Sir Ch. Rivers Wilson responded to the toast, in the main seconding Mr Garcke's contentions. Mr. Raworth, "in lighter mood," proposed the toast of "The Electrical Industry," to which Mr. George Herring and Mr. Percy Sellon responded. "The Visitors," proposed in a ponderously humorous vein by Mr. Stephen Sellon, and replied to by Major Cardew and Mr. Madgen, completed the toast list.

It must have been most reassuring to Mr. Garcke and his friends, for the success of their future operations, if, indeed, it did not come as a complete surprise, to hear Mr. Madgen disclaim that he represented *Lightning* on that occasion, and eloquently repudiate the policy of that journal, endangering its *raison d'être*, in fact, by agreeing wholly with Mr. Garcke's views, and boldly asserting that local authorities and the parish pump were all a huge mistake. To secure such a valuable ally is a feat of which Mr. Garcke may well feel proud, and probably this was one of the schemes to which he briefly alluded as having to deal with, but to which he did not, for many reasons, deem it necessary to specifically refer in the course of his very suggestive and interesting post-prandial oration.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution of Electrical Engineers, held at the rooms of the Society of Arts, on May 26th last, Mr. J. W. Swan, president, in the chair, Prof. Charles A. Carus-Wilson read a paper on "The Design of Electric Railway Motors for Rapid Acceleration." The writer gave an explanation of the contents and scope of his paper instead of reading it in full, the diagrams being projected on a screen and fully described. As will be seen from our columns, in which a reprint of the paper itself is given, the writer deals with the important question of the incidence of design as regards the motors employed in what in this country we prefer to call tramway systems, *i.e.*, those lines in which frequent stops are made, the intermediate runs being of comparative shortness. It is pointed out that in such cases efficiency may be of less importance than rapid speeding-up, while the loss of energy in the rheostatic controller, or even in the motor coils with a S. P. controller, may be so large relatively to the utilised energy, that any means of modifying the design to enable such loss to be reduced must be of value. To assist his argument, Prof. Carus-Wilson has introduced such terms as "induction factor" and "force factor."

The discussion was of a character which does not lend itself to useful summary; indeed, as several speakers remarked, the paper is one which requires careful and quiet study to do it justice, and we would apply the same statement to the discussion upon it. The speaker who opened the discussion drew attention to the idea of the controller introduced by Prof. H. S. Short, which is claimed to continue the acceleration more closely until the final speed has been reached. In his reply the writer may be said to have effectively combated the notion that Prof. Short has achieved any important advance in controlling by the aid of his apparatus. Down grades at the starting point were also referred to as straightening up the acceleration curve to a straight line.

Mr. Mordey had just returned from a short visit to the United States, and summarised his investigation of the present practice by saying that motors are now being made as large as can be worked with, the field being as strong as can be got, the tendency being to develop more and more powerful motors. The main principles seem to be much as they were years ago, the difference being in strength of field

size and weight. Study and ingenuity is being largely exercised in improving controllers, although many are even now imperfect, notwithstanding all the experience on the other side. Mr. Mordey joined with several other speakers in expressing pleasure that this subject should have been brought up just now for consideration.

Prof. R. H. Smith thought that quick time service was the importance matter on electric railways. It seemed to him that the calculations in the paper were carried out on the basis of a constant train resistance. Resistance could be divided into internal and external, the former being approximately constant; but this remark does not apply to the latter. The paper seemed to regard the matter from one point of view, the possibility of covering a certain distance in a certain time. Prof. Carus-Wilson afterwards acknowledged that if the stoppages were infrequent, the ideas embodied in this paper became of less and less importance as the steady runs occupied more and more space, and the length traversed at constant speed increased relatively to that in which acceleration was allowed. Prof. Smith pointed out another view, how to get work done as quickly as possible with minimum stresses in the machinery, and certain cases could best be met by dividing the whole distance traversed into two sections, in one of which uniform acceleration, and in the other uniform retardation, reigns.

Prof. Ayrton followed Mr. Mordey in his appreciation of the service done by the writer in preparing this paper, based on experience in a country where data from actual examples on a large scale was available. He appreciated the importance of reckoning the size, &c., of motors, as is done in the United States by the draw-bar pull, which he thought was the proper way to make motors. Nevertheless, he regarded some points in the paper as blemishes: he did not, in the first place, fall in with the unnecessary use of new words. We have names which have caught on with the British public—power factor, form factor—because of the word "factor." There was the expression in the paper "induction factor," which represented the induced E.M.F. at one revolution per second: he did not particularly know the use of the term "force factor." Prof. Carus-Wilson gave his reason for using the former term as being useful when the motor was at rest; there was a certain "induction factor" to be considered, although there were no induced volts whatever—it was therefore perfectly definite and necessary. Prof. Ayrton thought that air resistance had been entirely ignored in the paper, although different velocities were considered. In the case of a railway train air resistance cannot be ignored, and will certainly not be constant. Again, the argument would be modified, if the object was not to cover a distance in a certain time ending at full speed, but from a state of rest to rest. It was interesting that, although series motors were universally used, and had been always recommended so as to start freely, that the writer had shown that they were not merely better from a speed point of view, but also from an economy point of view.

Mr. E. K. Scott referred to the connection of motors. On some lines they were always in series, on others always in parallel. The use of down grades at the starting points might modify the practice of series parallel control. He also mentioned that the curves would be affected by the use of roller bearings, and asked the writer for some information as to the modification of the curves in this case.

Another speaker took Prof. Carus-Wilson to task for his terms and notation, and wanted to know whether his formulæ were empirical or rational. He considered that all formulæ of this kind should have attached to them sufficient explanation. Then the paper seemed to be dotted all over with assumptions. It was desirable that it should be stated to what extent these were purely arbitrary, and he rather thought some of these must be wrong. One word he would say on the question of acceleration. Some people seem to think that the design of the motors was the first thing done on a railway scheme, whereas the engineer found that the number of people to be carried per hour—the load per mile in a given time—had been settled before the problem was put into his hands, and he had then to design his trains to run on a schedule already prepared.

The President felt that the paper could be utilised as a record of valuable experience, as we are now beginning the construction of electric railways. Prof. Carus-Wilson then replied. The more important of his remarks have been noted above. The meeting then adjourned, the general impression apparently being that those members who found time hang on their hands in the coming holiday season could effectively dispose of it by studying the paper read that evening.

THE EFFECT OF LIGHTNING UPON OVERHEAD POWER CIRCUITS AND THE CHEAPEST METHOD OF DISTRIBUTING POWER.

By ARTHUR H. GIBSON, A.I.E.E.

The growing importance of an effectual protection against lightning, and the admitted inefficiency of most arresters, induces the writer to record these observations, with the hope that they may be found useful to some of your readers.

It was a long while ago that the spark discharges from influence machines suggested the zig-zag appearance of the lightning flash to be the natural side view of a spiral discharge, inasmuch as sparks from the machine had a zig-zag appearance, whilst, when viewed endwise, appeared as rings.

It is noticed that in altitudes of 5,000 feet above sea level the lightning discharges rarely present this appearance so familiar at lower levels, but take the form of a more or less wavy line, often bifurcating in its downward course. This is possibly merely an elongated spiral due to the rarefied air.

In power and lighting circuits, drum armatures, especially smooth cores, are very liable, indeed, to damage by lightning; ring-wound armatures are less so, whilst hole, or slot-wound alternating current gear and transformers are rarely damaged, though some alternators with coils laid upon flat iron surfaces are frequently in trouble.

The following concerns a power transmission plant installed in South Africa by Messrs. Siemens & Halske, of Berlin.

The district is particularly infested by lightning, and the arresters used were invented by that firm.

The whole plant has run through the rainy season without any serious damage attributable to this source.

The generators were approximating to "hole-wound," pressure being 3,000 volts between lines.

An arrester was fixed upon each of the three-phase lines, generally on entering a building. The arrester itself resembles a much enlarged I. H. arrester, but has no magnetic arrangements whatever. It consists of copper wire bent to shape, and supported *in situ* upon porcelain insulators, the distance across the two outermost points at the top being about 2 feet; each earth sector was carried to a separate earth plate.

It is interesting here to remark that the ohmic R, between two earth plates, each 5 feet by 3 feet, buried near to one another, was found to be 20 ohms. The soil at times is remarkably dry.

The arresters worked well, but were unfortunately arranged rather too close together; the distance between arrester and arrester was only 13 inches, resulting in a strong tendency to arc from pole to pole, with consequent burning and cracking of the porcelain insulators.

The action of the arrester evidently depends upon the arc to E, being carried rapidly upwards by the natural action of the heated air. The rising arc, rapidly increasing in length (owing to the shape of the conductors), eventually breaks.

When a set of arresters work, the effect upon the generators is much like that of a partial short circuit, and the generators emit a peculiar note as the speed falls for a second, during which time the arc has broken, and the machine being well governed runs up to normal speed and all goes on as before.

In more severe cases the circuit fuses will go, and possibly some instruments may suffer as well.

The nature of the discharges to E vary much; sometimes one or two bright sparks like those from a Leyden jar will snap across to E on one pole, only without any arc.

When the spark gaps are adjusted as close as $\frac{1}{8}$ inch, the discharge is explosive in character, and the circuit fuses go more often than they would otherwise.

The discharge which takes place when no current is on the line does not appear to be materially different from the usual, except that it may be of less duration.

Ordinarily the lightning seems to start the arcs to E, which are vigorously maintained by the 3,000-volt current.

As the plant runs continuously, testing any line meant a stoppage of machinery somewhere, thus it came to pass that tests were not often made.

It was soon found, however, that when an E was formed on a H.T. line it was made known, first, by the telephone system becoming paralysed, and, secondly, the arresters on that particular circuit worked more frequently than they should do.

It is interesting to record that for about a fortnight, a few hours after sundown, on each day a particular arrester in the largest power station worked when there was no lightning to be seen. This one was fixed too close to the roof, and in spite of asbestos linings, a volume of vaporised copper and reddish flame accumulated round the top of the arrester, not being able to escape by rising, the flames or arcs seemed to absorb the whole power from both power stations robbing all the circuits for about a second, the flame spread in an alarming way, giving out considerable heat. This diurnal discharge was assumed to be due to accumulated static charge of lines.

The telephone circuits, which ran underneath the H.T., suffered to a much greater extent than the power circuits—discharges which hardly effect the latter damage the telephones considerably.

As a result of observations, it may be said that electrical lines cannot be struck anything like so often as arresters work, or as often as damage is done.

Those who have had the privilege of seeing a flash actually strike within 1,000 yards, will have a distinct recollection of the circumstances, and, by the way, the writer and others who have done so, noticed a snapping sound apparently quite close, and a fraction of a second before the crash.

When such discharges do take place, every dweller within 1,000 yards radius may be pardoned for imagining, momentarily, that his own house is the particular spot.

Such a discharge will cause arresters to work and blow fuses in a circuit nearly half a mile away.

The following hypothesis explains these phenomena. If a lightning discharge strike the earth in the vicinity of a highly insulated line, or any insulated area, the earth potential in the locality is suddenly changed sufficiently to cause a smaller discharge to pass into the line to equalise potentials. The lightning flash only restores potentials to normal. The sun is the real offender, and it is not necessary here to recount the process of evaporation, electrification, condensation, and consequent accumulation of static charge which goes on preparatory to the flash.

If this supposition is correct, then discharges in most cases pass from earth to line, instead of *vice versâ;* but the effect upon the apparatus is the same.

Here arises the question. Why should earthed lines suffer? such as tramways, telegraphs and telephones. Prof. Oliver Lodge has shown what the impedance of a turn or two of wire means in the case of such discharges as these, and thus the trolley wire or telegraph line becomes a condenser of considerable capacity, whose outer coating is the world in general and the air the dielectric, the only path being the motor coils or relay magnet, which have such a high impedance that the current makes a short cut, so to speak, through the insulations.

Arresters of many forms have been tried, but the one that can effectually protect a smooth core drum armature does not appear to exist. Taking a general view of the question to-day, the wisest course to adopt in distributing power, where lightning is troublesome, is to stow the drum armature away and adopt the inevitable at once, *i.e.*, polyphase machinery, with sunk windings or hole wound. Apart from the lightning question, in any power distributing system in England there is a strong tendency to hang on to continuous current and perfect the commutator (only a reformed reprobate at best), while our neighbours across the pond have thrown it out altogether, and have their shops filled with orders in consequence. No worthy reason can be advanced for this slowness.

So long as our engineers persist in connecting up the alternator coils for single-phase, and then spending golden days at the infernal task of making motors to suit, so long shall we be at the tail end of progress. The time and money might be better spent in fighting out the patent right, seeing that we are legally supposed to be fenced in and the neighbours raking in the harvest outside.

Electric lighting will soon form only a fractional part of electrical work. Tramways will make enormous headway, and when the possibilities of electrical traction become generally known, the busy railways must, and will, be operated electrically. To-day the cost of copper and transforming stations for a 500-volt collection would make the would-be promoter's hair stand on end, but necessity will provide a better system; and here lies the crux of the railway problem—one rather too large for consideration at present.

The railway can become a duct of power and light, and the owner of the cotton mill by the wayside will cast out the boiler and engine and put in some motors, "because it is cheaper."

These prophetic remarks some may disagree with, but calmly work out the possibilities of a power station at the pit's mouth, with modern automatic coal-handling gear, and half-a-dozen marine engines of about 5,000 H.P. each and a 30,000-volt transmission, it will then be clear that such is possible, and must be cheaper than conveying coal to the various points. In other words, it is cheaper to send the power along the wire.

When this is recognised, the sooner the problem is tackled the better, or Uncle Sam and others will be demonstrating, just as in the case of the tramway. In fact, Uncle Sam is at it already.

MECHANICAL DRAUGHT.

Though, perhaps, open to the charge of special pleading, the publication by the Sturtevant Company of anything upon the subject of mechanical draught will command attention as representing the experience of makers of fans who have had a considerable experience in schemes of draught. Chimney draught, or so-called natural draught, is, *prima facie*, at fault, or it would not be found so often supplemented. For many years assisted draught was simply chimney draught helped on by other means, but now the chimney has come to be looked on in the light of an expensive superfluity. Artificial draught is made variously by steam induced air currents, by blowing engines and air compressors, and by fans, exhausters, and positive rotary blowers. The Sturtevant Company object to all except the centrifugal fan, which to-day is the accepted substitute for the chimney, and it may be applied in two ways, either to give a plenum by blowing air into a closed boiler room or a closed hearth pit, or by exhausting from the outlet end of the furnace, and merely a low chimney is required to deliver the gases at some height above floor line. Such was the system first, we believe, employed in England at the factory of Sir Henry Edwards, near Sowerby Bridge, in Yorkshire. Fans were placed at the back of each boiler which delivered air to a chimney only as high as the mill. The arrangement was said to have been due to a personal quarrel and litigation over a chimney, Sir Henry finally deciding he would have no chimney. With the closed ashpit system there is a tendency to blow flame out of the door, and obviously some chimney action is necessary to prevent this. Hence the use of double fronts in marine practice which serve to keep back the flame, and, of course, the air blast ought to be automatically stopped when the door is opened for stoking By this system the air may be heated by means of the wasted gases, an arrangement not practicable with the closed stokehold system. The ss. *Dania* showed an economy of 13 per cent. per day and a shorter voyage by 5 per cent. when fitted with fans as below:—

Conditions.	Days run.	Knots speed.	Coal per day.
Natural draught	17·00	7·50	9·76
Forced draught	16·21	7·58	7·75

The closed stokehold system is usually impracticable on land, and chiefly useful for naval purposes when ordinary steaming can be performed on natural draught, and the forced draught is used for emergencies to maintain high power, during an engagement for example. In the induced system, which is the most easily applied because it involves no change of arrangement, the fan can simply be placed in the flue to the chimney. Its leakages are always inward. Mr. Blechynden is quoted to the effect that with ordinary good arrangements a fan draught enables the steaming power of a boiler to be increased safely by 30 to 40 per cent. for continuous work, and by 100 per cent. for short runs, and this may be secured with a smaller fuel consumption per H.P., probably because the better draught permits of thicker fires and reduces the excess of air. Inferior fuel may also be employed, and we have known considerable economies to be thus secured. Equally important is the elimination of all weather conditions which sometimes put a stop to work. Fans may be large or small, as necessary to location, speed being inversely as size, and they may be of cast-iron or sheet steel.

It is recommended that as far as possible the fan driving power should be independent of other sources of power. The fan should have its own independent engine direct connected where possible, as usually it is with large fans. Induced draught by fans seems to be almost a necessity with garbage destructors. Thus at the Shoreditch destructors 12 cells, each of 25 feet square feet of grate area, heating six water-tube boilers, are blown on the closed ashpit system by three motor-driven fans of a capacity of 8,000 cubic feet per minute. They deliver by underground duct to the ashpits at a pressure of 3 inches of water, and they draw their air from the sewers, and to some extent from the space above the cells, where otherwise the men engaged dumping the rubbish would find the heat unbearable.

With a chimney, a certain temperature of the waste gases is an absolute necessity. With a fan there is no heat required, and where a fan is employed it is only reasonable that the waste gases should be cooled much lower than they ought to be with a chimney draught. The problem for engineers who employ fan draught is to secure this reduced waste temperature. With a better draught and properly arranged thicker fires on perhaps shorter grates, the excess of air admitted to a furnace will be reduced, and the furnace temperature will be higher, so that even the same final temperature will represent a less proportion of the initial heat, or, in other words, the final temperatures with and without fan may be alike, yet with the fan the weight of escaping gas may be only two-thirds or three-fourths of what it was without the fan. This itself means a large saving but with lessened temperature as well the economy will be even greater. Waste temperature may be reduced by using the gases to heat an air trunk to carry air to a closed ashpit where such a system is possible, and there are many factories where steam is used for heating drying stoves that could as well be worked from the heat of the waste gases either passed directly through pipes, or perhaps better used to heat air to be blown into the drying room by an independent fan.

ELECTRICAL SHOP TRANSMISSION.

In a recent paper by Mr. Dimick, read before the Chicago Electrical Association, attention was chiefly confined to a description of a plain two-wire 220-volt system with motors belted to line shafting in the various departments. Other systems used to some extent in American practice are the 220-volt three-wire and the 500-volt direct and alternating systems.

The author refers to the use of separate motors to each machine requiring power, but while this may be the most economical as regards power, unless the motors are needed of at least 5 H.P., the first cost is prohibitive in most cases. For 5 H.P. motors, however, it may be employed, seeing that motors can be purchased at per horse-power.

The two cases which usually come under an engineer's attention are the changing of the belt or rope driving of an existing shop, and the equipment of an entirely new shop, which is, of course by far the easier problem. The first case is often complicated by the necessity of avoiding any stoppage of machinery during the change, and this demands a good deal of ingenuity and scheming. The great question to decide is how much power does each section require, what will be the minimum, maximum, and average loads, and what allowance is needed for future extension. Often mere assumptions must be made, and on this point we think much might be done with transmission dynamometers, instruments for which there ought to be a considerable demand. Assuming that the various powers have been decided upon, the author states what is the practice in modern power plants with regard to the size of generator to be employed. Units are to be as large as possible, with one in reserve, especially if the day be of 24 hours, and it will usually be practical to have a small unit of 50 or 100 kw. for periods of small load and for overtime.

Besides the usual switchboard outfit there should be a recording ammeter or wattmeter in series with the bus bars, and a recording voltmeter. Distributing switches should be of ample capacity to provide for futures. An ammeter on each circuit is desirable, as it will save many future tests. There should be provision for ground test through the voltmeter. Cables from the generator to the board of not over 800,000 circular mils cross-section are easy and convenient for use. They can be doubled, trebled, or quadrupled, if needful, in parallel, and are cheaper to put up, and use less copper than larger cables. They should be lead covered between the board and generator.

The most expensive, and by far the best system of feeders to distribution circuits, are the lead covered cable in iron pipe, or in iron armoured conduit. The objection is the difficulty of tapping a circuit, but the cables are safe from injury, and from sagging and loops.

The terminals should be sealed or soldered into the fixtures. With lead-covered cables, a large sleeve is wiped onto the end of the cable and filled with a compound that will not run out if the end is pointed downwards.

For sub-division there is needed a switch and a plug fuse for each motor circuit on each floor at the junction with the main riser or feeder. The switches may be dispensed with—they are costly—but the fuses should remain. Fig. 1

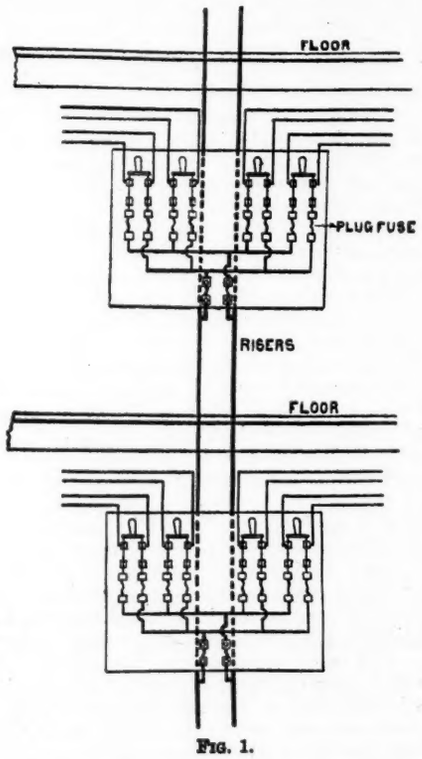


Fig. 1.

shows the arrangement of boards on the floors, while fig. 2 shows a branch block to be used on the ends of sub-feeders from the boards where more than one motor was required.

It ought to have a plug switch or fuse, and a fireproof cover.

The motor-starting apparatus ought to be alike all over the system. The switchboards should be of slate and uniform in size, and should carry a switch, a fuse, a starting box or rheostat, pilot lamps and ammeter, which is worth its cost, even if not absolutely necessary, for it shows when the motor is overloaded. The chief item is the rheostat.

There are two good rules. "Put in a motor big enough to do the work without over strain;" "use a good automatic starting rheostat;" on these two depend the success of

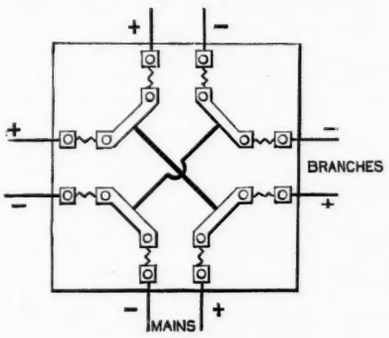


Fig. 2.

a motor transmission; say there are 100 or 150 motors in operation, and as many starting boxes, all the rheostats must return to the starting point of the circuit breakers open at the generator.

An automatic rheostat means, properly, one that will open the armature circuit as soon as current ceases to flow, and make it impossible to start again until all the resistance is in the circuit. Lately, overloads have been included also. A good rheostat ought to be thoroughly fireproof; the resistance steps should be proportioned to avoid injurious sparking at the switching segments or allow too great a difference of current to flow before the armature is up to speed; the segments should be large and massive; the contact arm easy to work, and the contact piece itself ought to be the point of wear and tear, easily removable and cheap. The segments and moving contacts must be kept clean and free from burned spots.

The automatic part is usually a magnet to hold the contact lever in position when the resistance is all out, and when the circuit opens from any cause the lever is thrown back to starting position by a spring, or by gravity.

Another magnet, or the same one, performs the same operation for an overload. These magnets are in series with the field, in series with the armature, or across the feeder terminals. The common troubles are the failure to act when it should, or it acts when it should not, and the burning of the segments or contact. Minor troubles are the burning out of the resistance coils or magnet spools, spring breakages, screws loose, contacts overheated, &c. There is a field for the rheostat that will perform its duty as above, and be free of half the troubles named.

Motors for steady work should have a 10 per cent. margin. Motors for a heavy load of a few hours, and a light load for the balance of time may be 15 per cent. over size. Motors rapidly changing from no load to full load, or reversed often and quickly, must be 20 to 25 per cent. larger; large liberal allowances will soon pay for themselves in repairs, especially in commutators and the waiting for new ones to be put in. Then there is always room for more machines in every large factory, and they ought to be provided for in a margin.

When completed, tests should be made to show where improvement is possible. Every machine can be tested as regards the power it consumes, and on this point we think engineers generally might tabulate any useful data by giving the power absorption of all machines they can indicate. Such information is very much needed. There is very little real knowledge of power absorption outside the textile mills, and there only with the addition of shafting, so many spindles going to a horse-power. Engineers' machinery, grindstones, grinding mills, cement grinders, and all manner of machinery in general trades are run very much on guess work. This is not as it should be.

No one seems to really know how much power it requires to run even a railway carriage, or, if known, those who know stick to the information.

CORRESPONDENCE.

Re Nash's Patent.

In your issue of May 27th you give a notice of the decision of the Comptroller *re* the Electrolytic Company's opposition to the grant of Nash's patent. As the terms in which the notice was made would convey the idea that the opponents had succeeded against us, we send you a copy of the Comptroller's decision, and copy of Nash's specification will be sent by our agents, Messrs. G. F. Redfern & Co., from these you will see that the decision is entirely in favour of Nash's patent. The word ordered to be struck out, and the disclaiming clause, do not interfere in any way with the construction of the apparatus.

So far from being a copy of any other patent, it has distinct advantages on any other apparatus for this purpose. The deposit is very ductile—a result which has not hitherto been obtainable. A substantial deposit is made in one-third the time in that taken by the opponents; it is much more convenient to use, the container being lifted from the vat without the use of ropes and pulleys, and, by using a duplicate container, the apparatus can be kept continually at work. By the use of specially made insulating material in the construction of the container we avoid the deposit of metal upon the apparatus, this being a decided advantage over the opponents.

To sum up the advantages of this apparatus we would claim:—a better deposit, convenience in use, and economy in time and material.

Kindly give this notice of correction in your next issue.

W. Canning & Co.

Lumford Mills, Bakewell.

Doubtless your paragraph with reference to our firm having purchased the above mill was inspired from some local paper. The facts are as follows:—We obtained an option of purchase of the mills, which we afterwards transferred to the D.P. Battery Company, who are now the owners of the mill. As there is 150 H.P. laid on from two large water-wheels, besides 150 H.P. from a "Marshall" condensing engine, we have little doubt that the company will shortly be producing accumulators at a price which has hitherto been considered impossible for first-class work.

Drake & Gorham.

ELECTRIC ELEVATOR INSTALLATION.

Americans shout so much over their performances which, when different from European practice by reason of climatic and other environment, they claim as evidence of superiority, that it is a marvel they have so little to say in respect of their systems of elevators, for in this branch of engineering they are really and without contradiction far ahead of Europe. Should an American ever enter the mouse ladder as it is found at, say, the Mansion House Chambers, he would become hopelessly insane before he reached the fourth floor. In America tall buildings and rapid elevators have acted and re-acted upon each other, until the one has grown out of all reason and the other has become a very perfect piece of machinery. Stairways in an American office building are there, but are hardly used. Some idea of the business in elevators may be gathered from the *Engineering Magazine*, wherein Mr. P. R. Moses states there are more than 6,000 in the city of New York alone, and these make over 500,000 trips per day, and carry more passengers than the tramways or the elevated railroads combined. Our author considers that the new electric underground railways of London will concentrate business in London in the same way as it has done

in New York, and lead to 12-floor buildings in spite of the building law. While we do not think the author can have appreciated the different conditions of London and New York, and the fact that the concentration of New York business is not likely to be paralleled in London, we do entirely agree that there is room for an entire change in the London system. In London, office buildings are much too small, and their arrangement is of the worst. The building we have referred to is an example of thorough badness; it is also an example of one large enough if properly arranged to afford at lease three rapid elevators. London office buildings are badly worked, in fact, there is no working at all about them. An ideal office building is warmed and lighted, fitted with a centrally-controlled clock, and supplied with at least one elevator for each 75 rooms, under charge of an attendant who is there when wanted. Compare this with Leadenhall House, with its slow service and minutes of waiting, and it is easy to see why upper floors in London bring such small rents, while in New York they bring in practically as much as the lower floors. The future elevator will be electrically operated. Elevators are machines demanding severe mechanical conditions to be fulfilled. They attain a speed of 600 feet a minute in about five quarter seconds without a jerk, and they decelerate equally quickly. They must be safe. They have the enormous advantage that they always have a clear road, and can be fully open for inspection. Passenger elevators of high speed vary from 300 to 700 feet per minute. Below 150 feet is considered low speed. Freight elevators do not exceed 300 feet. Three types of electric elevators have been perfected. One is the device of a screw and multiple sheaves, the screw taking the place of the ram of the hydraulic Otis lift, and the cage hanging upon the single fall end of the rope, which is wound round the multiple sheaves.

The second type embodies the double worm gear drum, and the third type is that of the single worm gear drum, the second variety having the advantage over the third in the well-known balance effects of the double worms. Each of the worm gear types has the motor on the worm-shaft, the worm operating a large worm-wheel on the cage rope drum. Motion is arrested by removal of power, and by brake on the motor-shaft, or by closing the motor circuit through a resistance, and causing work to be done by the car through the motor. The screw type, which was contrived to imitate the Otis type, raises the cage by power, and lowers it by gravity. Ball-bearing nuts are used on the screw, and the multiple sheaves multiply the nut travel about 10 times. In a 200-foot building the nut must, therefore, travel 20 feet on the screw. The conditions to be filled are very various, and depend on the kind of work and the space available. A small available space may be utilised by high speed machines and skilled attendants. Apartment houses, with women and children, obviously require different treatment from a busy office building. In small buildings the power to be used becomes a question, if available from some public station.

Again, the heating system of a building affects the type of engine to be employed. Safety is the primary requisite. Hence there must be safeguards against dropping, should ropes fail; against excessive speed; against all sorts of conditions of overload, and for automatic arrest of motion at the limits of travel. All parts of vital importance, as the sheaves, ropes, lines, &c., must be of far excessive strength, which costs little.

One system of control allows of speed being varied by the attendant in the car; the second does not, except for starting or stopping. The first method is secured in two ways: by a pilot motor operating to vary the resistance on the main circuit, as in the Sprague system, with an inverse variation in the motor field strength; the second, by the Leonard or variable voltage control, where each motor has a separate generator, and the car speed varies in accordance with the electric pressure in the generator, this being determined by a resistance in series with the small field current, and is adjusted from the car. The Leonard system is employed only on worm gear machines, and could not be operated on the screw machines. The system of varying voltage is an ideal one for start and stop, either from the economy or comfort standpoint. On the other hand, from the point of total economy, the rheostat control is advisable, because of the continuous operation, and the first cost of a separate generator for each machine. The proportion of time during which the car is moving rarely exceeds five-eighths, and generally falls below one-half the total nominal hours of work. Each generator must be sufficient for starting loads, and therefore runs at a low efficiency. Data of 17 elevators picked at random from 100 tests show speeds of 60 to 450 feet per minute; maximum capacity 1,500 to 3,000 lbs. live loads from a minimum of 150 to a maximum of 1,600 with an average of 593. In a tall office building the average load was under a seventh of the maximum, and even where elevators were worked to their fullest capacity the average load did not exceed a fifth of the maximum.

Applied to worm-gear machines, the system of variable voltage is shown to be less economical and simple than the rheostat control, but is superior in smooth starting and operation. In low speed buildings, where variable speed is not essential, a solenoid control answers well; it may be operated by electricty from the car, or the shipper rope and wheel may be used to close switches, and operate a brake.

House elevators have automatic control, and include push buttons on each floor, to bring the car to the landing; automatic locks to hold the doors till the car is there; door switches to prevent movement while the door is open, and a means to prevent the car being called by more than one person at a time. Spring and trigger actions are to be avoided, and positive action substituted. An important branch of control is the car stopping which has to operate under such various conditions of load and speed, and where loads are heavy, the car ought to perform work, and a device for this is necessary to easy operation. For high-speed machines the car must likewise do some work on the brake band, as well as electrically by short circuiting.

The use of brakes with worm gear depends upon the variety of worm. Low pitched threads, of course, will not start under car pressure, but coarse pitches will reverse, and a brake must hold the car or it will run the worm. With fine pitches the brake becomes simply an emergency stop. The flat pitch worm is less economical, but has the added element of safety. The question of counterweight is important, and theory shows that a minimum of inertia must be sought. The car should in practice have a fourth to a half more downward force than the balance weight. On drum machines there may be two weights, one on the car of two-thirds its weight unloaded, the other on the drum equal to the unbalanced weight of car and to the average load. In high buildings a variable counterweight attached to the balance and to the car to balance the rope variation may be used in the form of a chain hung to both car and balance.

In high speed service a car must never be over-balanced, the excess counterweight system is at fault and should be abolished, for in case of accident, the ropes are sure to break when the car is at the top and drop the car, if safety appliances fail. Counterweights may be arranged to move at half or a third the car speed. This reduces inertia, and reduces the cost of the weight guides and ropes. A useful speed is that which in any building will make the round trip without a stop in half a minute. This is a good rough approximation, and may be modified to suit exigencies. Special elevators for upper floors only are a doubtful success. Call pushes at the various floors and car position indicators help the service speed. In high buildings the large inertia, due to high speed, must be met by strong cables, fixed limits of travel, and underbalanced cars, with slow moving counterweights, conditions only filled by hydraulic or screw electric machines, and not at all suitable for gear drum machines, which cannot accomodate triple ropes on the drum.

With the screw and ball nut there are multiple sheaves on the nut, the rope from the last sheave going to the bottom of the counterweight and to the top sheave of the weight, other ropes pass to an anchorage at the building top, and to the overhead sheaves of the car. An interval of one second, with the screw making 250 turns per minute, would carry the car 8 feet 4 inches, with a 20 to 1 multiplication. Any higher speed must be by increasing the speed of screw. Worm gear drum elevators are all right below 350 feet velocity per car. They are accorded little cars in residences, apartment houses, or sidewalk hoists, and must be self-oiling, have self-cleaning switches, enclosed motors and parts, and arc arresters. All types of elevator require strength, sparkless commutation, ventilated armatures, carefully secured lugs and winding, no sharp corners, fields variable and balanced, and they ought not to be highly speeded. Hoistways should be skylighted, fireproof, and with screen below overhead machinery. There must be a space above and below as a safeguard against slip or stretch of ropes.

With worm-gear elevators in numbers, descending cars help to raise those rising, and economy results.

Elevators are more cheaply worked by electricity than by any other means. The power per car-load in office buildings varies from 2 kw. hours, with overbalanced worm gear, to 4 kw. hours with unbalanced screw. Central station costs, of 10 cents per H.P. hour for small, to 10 cents per kw. hour for large consumers, are $3 to $10 for residences, $10 to $20 for apartment houses, $15 to $40 for loft and small office buildings, and $40 to $60 for tall office buildings, per month. To the question of safety, the answer is that no person has been killed outside their own fault. No electric elevator has fallen, and they run in most unsuitable places for machinery.

Surely, in London, where there is such an outcry for the day load, something might be done to get electrical elevators to work, even in such buildings as do exist. But we wonder continually that our architects have absolutely no ideas as to the conveniences and uses of buildings. Their one idea is to present something that will look well from the street—we don't say they even do this; but they certainly are destitute of all internal ideas, and in this respect they ought to study America. One need not go up 12 floors or even eight. A properly designed six-floor building would provide double the convenience of an existing London office building. Why has London not absorbed the desk room idea. In New York a man hires simply desk room in a large building as big as a bank. He has room for his desk, a safe, and has the use of all conveniencies and a good address for money that would only rent a poor room out of sight in a dirty corridor up a back flight of London stairs. We have much to acquire from Americans in this respect, and the elevator is what is wanted to secure this end. Once get a large number of elevators in London, and the rebuilding or internal remodelling would be bound to follow.

THE CHELMSFORD SHOCK FATALITY.

AT the inquest held at Chelmsford on 23rd ult. into the death of Edward Fell, of the Chelmsford Electric Lighting Company evidence was given to the effect that deceased had been in the employ of the company since they first undertook public lighting eight or nine years ago.

ERNEST GARRARD, an articled electrician at the arc works, said that on the morning of the 21st ult. about a quarter past ten, he was with the deceased in Conduit Street. He was going to switch off a transformer, and witness assisted him to remove a lid from a surface box. They took the lid off, and deceased got down into the pit.

The CORONER: When the lid was on, the current would be running?—WITNESS: Yes, unless it was switched off at the works.

Is it possible to switch off the current in the pit?—No; only the secondaries.

Did you receive any instruction that morning at the works as to where you were to work?—No.

Did deceased tell you that the current was running, as he had not switched it off?—No; we knew it was charged.

Where would he switch it off?—In the engine room, on the switchboard.

When you go to these boxes, whose duty is it to switch off the current?—The switchboard man, but if he is not present the man who is going on the circuit would switch it off, place a ticket on the board with the words "on circuit" upon it, and then sign his name in a book.

What happened when he got into the pit?—He switched off the transformer. This means that he cut off the current between the transformer and the private houses, but that the current between the transformer and the works was still running.

Was there anything to show that there was current running between the transformer and the works?—No; but the transformer was humming, and he knew it was on.

Had he said anything about turning it off before leaving the works?—It was not necessary, as we were only going to take off the secondary wires; and, for that purpose, the switching off of the transformer has the same effect as if the current is switched off at the works. I do not think that he thought anything about the switching off until he got to the pit.

Was he in the act of switching off the transformer when this happened?—He had already switched off, and, as far as I could see, was coming out of the pit when his right hand accidentally touched the wire. He did not catch hold of the wire, but simply touched it.

And he was accidentally killed?—Yes.

The wire was charged to the extent of 2,000 volts?—Yes.

Is it usual for men to work in these pits when the current is running through them?—If a man goes to work in a pit, he knows which circuit he is going on, and he switches the current off at the works before going into the pit.

Did you hear deceased give anyone instructions to have the current switched off that morning?—No.

Has he worked in the pit before with the current running?—Yes.

Is it a rule to work in them when the current is on?—It is a rule that the men should not go into a pit when the current is on. They have no right to touch the "leads" at all.

The man had no right to work in this pit with the current on?—Certainly not.

Replying to further questions, Witness said the men who worked in the pits were supplied with rubber gloves and boots, and also with a written notice stating "No one is allowed to touch wires carrying high-pressure currents, except in cases of emergency, and then only when wearing rubber gloves." Deceased was not wearing gloves on Saturday.

Do you know why?—Because he had no intention of going on the high tension circuit.

How large are these pits?—Some are very large, but this one is very small. It was never intended to be a transformer pit, but he put a transformer into it.

A Juror: Are the wires protected in any way?—Witness: They are insulated.

How was it that when he put his thumb upon it this insulation did not act?—Simply because the current inside was at such high pressure, and I think the cable was damaged by the wet. He had no gloves on. There you are!

Do you think that if he had had gloves on this would have happened?—I do not think so.

A Juror: If he had touched his leg against the wire do you think the effect would have been the same?—Witness: I think so.

A Juror: Are these wires supposed to be safe if you touch them?—Witness: Oh, yes; the contractor guarantees them to be, but we won't take the risk.

Was it damp when he touched it?—Yes, it was wet, and the ground was damp. This had a great effect upon it.

Mr. Duffield (representing Messrs. Crompton): Is it necessary for a man to get into a pit at all?—Witness: Not in this case; but I think this is the only one of its kind.

Mr. Gray (representing the widow of the deceased): If a man is not going to touch the high pressure wires he will not wear gloves?—Witness: No.

Are there any printed regulations dealing with these secondary wires?—No; they are not necessary.

Then he did nothing out of the usual that morning, apart from the accident of touching the wire?—Nothing out of the ordinary.

Was this transformer a temporary arrangement?—No; but the big pit near the Oak is being constructed to abolish all these wretched little pits.

The present little pit with a transformer is not considered satisfactory?—No, I do not think so.

The Coroner: In your opinion it is not satisfactory?—I am not a judge; but if a man is to be killed as easily as that, I should say it is not satisfactory.

In reply to further questions by Mr. Gray, Witness stated that on Saturday morning deceased received instructions from Mr. Entwistle to remove the hoarding which had been erected over the pit at the Royal Oak corner.

Mr. Duffield: The removal of that hoarding had nothing to do with this accident?—Witness: Yes, it had, because in order to remove two lamps on the hoarding the transformer had to be switched off.

A Juror: Did Fell know that the wet was so great that it would make the wires dangerous?—Oh, yes.

Yet he went into the pit?—Yes.

Do you consider it was his own neglect that brought him to his death?—Yes.

A Juror: Has Fell ever been suspended for a week for not wearing gloves?—Witness: Not to my knowledge.

Not after his last accident?—Not to my knowledge.

In reply to another juror, Witness added: If the pit had been larger I could have got down and knocked him off the wire, but it would have been of no use. I ran over for James Brown, and we lifted him out.

Mr. Gray: What reason have you for saying that his death was caused by his own neglect?—That is a very hard question to answer.

You have told us that he did nothing out of the usual way, and that the touching was an accident. Where was the neglect?—Going into a pit in which there were high tension wires without gloves.

But you told me that it is not usual to wear gloves when a man is only going to touch secondary wires?—That is so.

Then it is not true to say that there was any neglect?—No.

These wires being guaranteed insulated, you would not expect a shock?—No.

A Juror: I have seen the man down this pit several times. It is so small that I do not think he could take a knife out of his pocket without touching the side with his elbow.

The Coroner at this point announced that he should not conclude the inquest that day, and that, after hearing the doctor's evidence, he should adjourn in order to give the Board of Trade an opportunity of being present.

Dr. Bodkin stated that when called to the deceased he was quite dead. Witness examined him and found an injury to his right hand. The thumb, together with a portion of the joint, had been what he might describe as blown away—burned off. There was a tracing up the arm where the electricity had apparently gone, the skin being taken off just as one would peel an onion. Death was due to shock, and had been, he believed, instantaneous.

The Coroner: Did the shock go to his brain?—Witness: No; I think it went through his body to the earth, and so interfered with the heart's action.

The inquiry was adjourned till Thursday, 26th ult.

When the inquiry was resumed the Coroner said: Since our last meeting, I have communicated with the Home Office with regard to this matter, and their inspector was down here just now, but he considers that it is not a matter that comes within his department. I understand that Major Cardew has been down and made investigations for the Board of Trade. Therefore, if he considers it a case which he ought to advise the Board of Trade to afterwards take up, he may do so; but we shall have no one here from the Board this afternoon.

William Entwistle, engineer to the Chelmsford Electric Lighting Company, said that he superintended the running at the lighting station. On the Friday evening he gave deceased instructions to remove the hoarding around the work which had been going on near the Royal Oak Inn. Witness knew that there was a wire on the hoarding which it would be necessary to remove, because he ordered it to be put on. Deceased placed it there himself a fortnight before.

The Coroner: Was it necessary to switch off the transformer in order to remove the wire from the hoarding?—Witness: It was not necessary; and Fell switched it off for his own convenience.

Then it was not absolutely necessary to switch it off?—Not necessary at all. Could the wire be removed with perfect safety without being switched off?—Yes, with perfect safety.

Was there any necessity at all for the deceased to get into this pit on this particular occasion?—There was no occasion for him to get into the pit to switch off the transformer. I do not know whether he had any other reason for getting into it.

Could he have carried out his work quite as well without doing so?—Yes.

Can you tell us the size of this pit? Is it an ordinary-sized pit?—It is one of our smaller pits, and the approximate dimensions are 2 feet 6 inches × 2 feet.

A Juror: Inside the pit is only 21 inches × 26 inches.

The Coroner: Have you ever had occasion to speak to the deceased for doing any work without wearing gloves?—Witness: I have never had occasion to do so.

Have you ever warned him?—I have admonished him. I do not mean that I have ever caught him handling wires without gloves, but I have warned him against touching them.

Are these wires supposed to be safe?—If the wires are in a thoroughly sound condition, they should be quite safe when charged, even if touched without rubber gloves.

Is dampness likely to make them dangerous?—When the rubber insulation is sound it should not make them less safe.

Are you of opinion that this small pit was safe to work in?—It was not safe for any man to work in. I should forbid any man on the job, barring Fell, to get into the pit.

Owing to the smallness of it?—Yes.

I presume you mean by that that Fell was the most experienced man you had?—Yes. As foreman it was his place to forbid anyone to get into this pit without his permission.

You are of opinion that he was aware of the danger he was running in going into it?—I am certain he was.

Can you form any opinion as to what possessed the deceased to get into the pit?—The only reason I can think of was to have a look round the pit and inspect it, to see whether it was wet. It was usual for him to inspect the pits after wet days to see if there was any water in them. To do this it was not absolutely necessary that he should get into the pit, but he could inspect them better by getting into it.

Replying to Mr. Gray, Witness stated that it was not usual to switch off the current merely for inspections, but such inspections would not include the handling of wires.

Mr. Gray: Then the getting into this pit was the correct thing to do?—Witness: As an intelligent workman he should have thought it

was not the correct thing to do, and if I had been there I should have warned him against it.

Have you not been in this pit dozens of times?—Yes.

When the current was on?—Sometimes.

Therefore you would not think it a foolhardy thing to do?—No, but an unwise thing.

Yet you have done it dozens of times?—Yes.

There is plenty of room to get into the pit without touching the wires?—Yes, if they are properly adjusted. Fell had put in some new cables about a week previous, and left them in such a manner as to be almost dangerous.

Replying to Mr. Duffield, Witness stated that he had known Fell for some time, but he did not think he was a careless man; he was a very fearless man. He had been a sailor, and was in the habit of doing things on the poles which witness would not attempt.

Witness, continuing, stated that deceased had an accident about four years ago, and after that he was more careful for a time. It was improper for deceased to touch the high tension wires without gloves, and witness did not think that he did so deliberately on the morning of the accident. It might have been done under some sudden impulse.

Mr. Duffield: Was the getting into that pit dangerous?—Witness: I consider it was, in the condition it was in that morning.

Was Fell in a position to know that?—He did know it: I am sure of that.

A Juror: Would the damp make the electricity pass through the covering of the wires?—Witness: Damp will not affect the covering if the rubber insulation is sound.

Do you think he touched a bare wire?—He touched a piece of wire which was imperfectly insulated. The insulation of it had been weakened by water.

A Juror: Had the deceased made some temporary joints?—Witness: Yes, and they were defective.

And it was by touching one of these joints which he had himself made that he met with his death?—Yes.

The Coroner: Do you think that the joints were unsatisfactory?—Witness: Yes.

James Brown, a labourer, in the employ of the company, said: I had been working in the new pit near the Oak Inn with the deceased and a man named "Sonny." The deceased went across to the new pit. Shortly afterwards Garrard ran to me, and said, "Where is Sonny? Teddy has got a shock." I went across at once, and saw the deceased lying at the bottom of the pit with his thumb touching one of the leads. Sparks several inches long were running off his thumb. I knocked his hand off the wire, and pulled hold of his coat and lifted him out as soon as I could.

Mr. Bennell: Had Fell had a shock the day before?—Witness: I have heard that he had one the day before, on the Baddow Road.

The witness Garrard was re-called. He said that when the deceased received the shock he had hold of some leads in one hand, and in some way the other hand came into contact with the high tension lead. Whether this was done accidentally he could not say. He could not understand how Brown could have knocked deceased's hand off the wire, and thought that what Brown saw was the installation on fire.

Mr. A. H. Pott, the chief engineer of the company, said deceased was an excellent workman, but was very careless in his work, and witness had had to caution him lots of times. He had not, however, caught him doing anything absolutely dangerous for some years. On one occasion he saw him handling wires with gloves that were so wet that sparks were crackling down the back of his hand, and on another occasion his hat touched a wire, and sparks crackled all down his back. Deceased merely said that he felt queer, and witness told him to get away from the wire. The pit in which deceased was killed was one of the first two erected in the town, and was passed by Major Cardew before it was used.

Replying to Mr. Gray, Witness stated that he was surprised to hear that Fell had been in the pit, even to inspect it, when the current was on. He did not know that Mr. Entwistle had also been in it; to get into it when it was wet was a very foolhardy thing to do.

The jury, having consulted in private, returned a verdict of accidental death.

Mr. Duffield said the company were exceedingly sorry that this accident had happened. The deceased had been an excellent servant, and the company had trusted him, perhaps, more than they had trusted any other man in their employ.

The Coroner said that, from what he had heard, Fell must have been an excellent servant, although he might have been a little too venturesome.

BUSINESS NOTICES, &c.

The Care of Steam Boilers.—Messrs. R. Hargreaves and Sons, 4, Richmond Terrace, Blackburn, are sole agents for Waddicar's improved patent for preventing formation of scale in steam boilers, and removing dirty waters and sediment. It may be fitted to any part of the boiler considered most convenient. It is connected to the outside of the boiler by a pipe, which allows dirty water to be drawn from the bottom of the boiler at any time when working. The apparatus is constructed to allow of a rotary motion, which prevents the sediment adhering to the bottom of boiler, so that by the regular use of this apparatus the formation of scale is entirely prevented, thereby maintaining the evaporative power and efficiency of the boiler. The apparatus has to be opened three times a day, and one inch of water drawn off each time.

Electrical Wares Exported.

Week Ending May 31st, 1897.	£	s.
Albany	47	0
Alexandria. Teleph. mat.	118	0
Amsterdam	60	0
Bangkok	24	0
Berbia	35	0
Bombay	441	0
Boston	24	0
Bundaberg	8	0
Buenos Ayres	522	0
" Teleg. mat.	223	0
Calcutta...	250	0
Cape Town	3,528	0
Colombo...	418	0
Copenhagen	110	0
Demarara	20	0
Durban	593	0
East London	537	0
Flushing	11	0
Fremantle	16	0
Gothenburg	19	0
Hiogo	26	0
Hong Kong	12	0
La Plata	38	0
Malaga	23	0
Malta. Teleg. mat. ...	38	0
Melbourne	207	0
" Teleg. mat.	387	0
Passages...	260	0
Penang. Teleg. mat. ...	65	0
Port Elizabeth... ...	2,564	0
Rosario	200	0
" Teleg. mat. ...	62	0
Rotterdam	12	0
" Teleg. mat.	31	0
Rouen	40	0
St. Petersburg	300	0
Singapore	28	0
Stockholm. Teleg. mat.	1,103	0
Sydney	341	0
Teneriffe. Teleg. mat.	290	0
Trieste. Teleg. mat. ...	220	0
Trinidad	60	0
Yokohama	56	0
Total ...	£13,337	0

Week Ending May 31st, 1898.	£	s.
Antwerp	36	0
Brisbane. Elec. fuses...	50	0
Buenos Ayres	24	0
Calcutta...	70	0
Cape Town	193	0
Christiana	33	0
Colombo	311	0
Durban	211	0
East London	400	0
Fremantle. Elec. fuses	50	0
Geraldton	99	0
Gothenburg	59	0
Hamburg	20	0
Havre	15	0
Madras	15	0
Melbourne	65	0
Port Elizabeth	227	0
Rangoon	44	0
Rouen	230	0
St. Petersburg	42	0
Shanghai	266	0
Singapore	1,292	0
Sydney	85	0
Trinidad	21	0
Wellington	117	0
Yokohama	30	0
Total ...	£4,010	0

Foreign Goods Transhipped.

	£	d.
Bangkok ...	1,550	0
Leghorn. Electric meters ...	43	0
Total ...	£1,593	0

	£	s.
Shanghai. Teleph. mat.	6	0
Trinidad. Teleph. mat.	56	0
Total	£62	0

Change of Address.—Mr. R. F. Yorke has removed from 51, West Regent Street to 48, West George Street, Glasgow.

Electric Pumping Plant.—The Better Bed Coal Company, owners of the Fell Greave Colliery, Huddersfield, have for some time experienced delays and difficulties in working the coal owing to the flooding of the mine. To overcome these difficulties the company have ordered an electric motor and pump to be fixed in the workings. The dynamo is compound wound, capable of giving 230 volts and 18 amperes at 1,050 revolutions per minute. It is driven by the hauling engine at bank, and is connected to motor and pump by a pair of 7/18 vulcanised cables at a distance of 400 yards, the motor being geared down from 1,050 revolutions to 60 revolutions by belt and pinion wheels. The motor is of the enclosed type, the lubricators being of the ring pattern. Dynamo and motor have been made by Messrs. Rosling & Appleby, of Bradford. The pump is of the double action type, and has been made by Messrs. G. Kendal and Co., Huddersfield. It is capable of delivering over 1,200 gallons per hour. The work has been carried out under the superintendence of Mr. J. Makin, electrical engineer. The plant has been working for three weeks, and has given entire satisfaction, having overcome serious drawbacks.

Electric Cranes.—It is stated that it is proposed to erect powerful steam or electric cranes at Calais and Dover for the transfer of mails and baggage.

Fined.—The Tudor Accumulator Company, Limited, were fined £3 at Dukinfield Police Court, for a breach of the special rules of the Factory Acts by not providing a bath for the use of their workpeople engaged in dangerous occupations. It was stated by the Government inspector that over a dozen cases of lead-poisoning had occurred among the workpeople.

Harrison, Coles & Co.—Notice has been given that the electric lighting business lately carried on by Harrison, Coles & Co., at Richmond, S.W., will in future be carried on by the Thames Valley Electrical Engineering Company.

Liquidation Notices.—Last Friday's *London Gazette* contains notice to the effect that at a meeting of the Fowler-Waring Cables Company, Limited, held on May 25th at 110, Fenchurch Street, E.C., it was resolved to wind up voluntarily. Mr. Geo. Fleming, of 9, Billiter Street, E.C., and Mr. J. A. Blackwood, of 110, Fenchurch Street, E.C., were appointed liquidators. It will, of course, be remembered that this concern was recently taken over by the Western Electric Company.

A meeting of the Wigston Electrical and Engineering Company, Limited, is to be held at 24, Friar Street, Leicester, on Friday, July 1st, at 3 o'clock, to hear an account of the winding up from the liquidator.

A meeting of the Gas and Oil Engine and Dynamo Company will be held at 1, Queen Street, Cheapside, E.C., on Tuesday, June 28th, at 4 o'clock, to hear an account of the winding up from Mr. Edward Lintott, the liquidator.

At meetings of the Cowper-Coles Zinc Extraction Syndicate, held at the offices, Mellanear, Hayle, Cornwall, on May 5th and 21st, resolutions were passed to the effect that it is desirable to reconstruct the company, and for that purpose that the company wind up voluntary, Mr. T. S. Lowry, of Camborne, being appointed liquidator.

Lists.—Messrs. Washington & Co., of Sowerby Bridge, Yorks, send us an illustrated price list of continuous current electric motors.

Messrs. Strasser & Rohde, Glashütte in Saxony, have issued a list, showing various micrometers of convenient sizes.

Lloyd & Lloyd v. D. & W. Henderson.—On 24th ult. Sheriff Strachan delivered his judgment in this case at Glasgow. The action it will be remembered was taken at the instance of Messrs. Lloyd & Lloyd, of Coombswood, Birmingham, the holders in the United Kingdom of the letters patent of the Benardos system of electric welding, against David and William Henderson & Company, shipbuilders and engineers, Glasgow, to recover the yearly royalties for 1895, 1896, and 1897. The Sheriff assoilzies the defenders from the conclusions of the action, and in the note to the interlocutor his Lordship remarks that the indenture and agreement bear that full license and authority was granted to defenders to use the inventions, and in consideration of the license defenders bound themselves to pay on January 1st, 1893, £200, and on each succeeding January 1st, £200. They paid pursuers in 1893 £200 and in 1894. On December 18th, 1894, they intimated that they were not to use the patented processes any longer. Pursuers insisted on payment whether the processes were used or not, and in this action they sue for the royalties due in 1895, 1896, and 1897. It was maintained by defenders that no valid or effectual license was entered into between the parties. On January 17th, 1893, the license was signed by Mr. Andrew Pitcairn Henderson, a partner of the defenders' firm, with the consent and authority of the other partners, but not in presence of witnesses. In consequence of the plea stated by the pursuers the Sheriff says he directed a case to be prepared and submitted to English counsel for his opinion on the question whether the indenture and minute of agreement was a valid and effectual license according to the law of England. Mr. Danckwerts, an English barrister, has given an opinion thereon to the effect that the deed was not valid or effectual according to the law of England. The pursuers objected to the opinion, but his Lordship considered the objection not well founded. If the validity of the deed was to be determined by the law of Scotland the Sheriff had no doubt it must be held invalid. Not one of the solemnities required by that law in regard to the execution of deeds had been complied with. If the deed was held invalid and ineffectual the action fell.

The Royal Engineers and Electricity.—General Sir Richard Harrison, K.C.B., C.M.G., the newly appointed Inspector-General of Fortifications, paid his first official visit to Brompton Barracks, Chatham, this week, and among his various duties he inspected the Electrical School at St. Mary's Barracks. This school is now very important, as the Royal Engineers are so very deeply connected with this branch of science, and both officers and men daily undergo instruction in all branches of electricity here.

Royal Institution Soirée.—On Friday last, at the Royal Institution *soirée*, the Edison and Swan United Electric Light Company showed the latest 1898 improvements in Ediswan apparatus. These included a patent dry cap lamp for use in damp places, or for outside lighting. The cap is attached by means of a brass disc, and is fastened to the glass bulb by specially prepared cement, which is thoroughly damp proof. Also a patent casing cut-out. Each casing cut-out is provided with four brass thimbles, adapted to the connecting cables, and these are held in position by the form of the porcelain case, without screws, and are easily removable. Provision is made for holding reserve fuses. There was also a patent direct contact high voltage lamp and holder; the holder is wired without being taken to pieces; the wires pass direct to the spring contact pieces which enter cavities in the lamp socket; there is claimed to be no possibility of short circuiting, and the work of wiring is greatly facilitated. Also the patent anti-shock switch for high voltage, an improved "Tumler" pattern, with patent enamel liner, and the patent anti-shock holder for high voltage, an improved "S" holder, with patent enamel liner.

Smoke Nuisance.—At the Greenwich Police Court on Thursday last week, the summons brought against the Crystal Palace District Electric Supply Company, Limited, and Mr. B. G. Blanchard, their secretary, of Springfield Works, Wells Road, Sydenham, by the Lewisham District Board of Works for an abatement of a smoke nuisance was adjourned *sine die* on payment of five guineas costs by the defendants, it being stated by Mr. E. Wright, clerk to the Board, that the nuisance had been abated.

The Metropolitan Electric Supply Company was, on 26th ult., again summoned at the Marylebone Police Court, at the instance of the Paddington Vestry, for causing a smoke nuisance from their Amberley Road station. After discussion the summons was adjourned *sine die*.

At Clerkenwell on Tuesday Messrs. Walter Scott and Co. were summoned for using, at the Chancery Lane Station of the Central London Railway, a furnace and steam engine which were not so constructed as to consume the smoke arising therefrom. The Holborn District Board of Works prosecuted. The magistrate, after hearing evidence and arguments, dismissed the summons, holding that the furnaces were, as far as possible, constructed so as to consume their own smoke.

Testing Magnetic Steel in Bulk.—Mr. Robert Jenkins, of 88, Bishopsgate Street, E.C., writes as follows:—"I see in this week's REVIEW a communication headed 'Testing of Magnetic Steel in Bulk,' wherein a reference is made to the output of the 'South Staffordshire Steel and Ingot Company, Limited.' This name is incorrect. The firm whose analysis and whose output are given is that of Messrs. Alfred Hickman, Limited, of the Staffordshire Steel and Ingot Iron Works, Bilston, for whom I act as agent in electrical business."

Veritys, Limited, v. Sharp.—With reference to the above in our last week's issue, Mr. Sidney Sharp, of 34, Victoria Street, Westminster, desires us to state that he does not carry on contracting work, and that the defendant in this case is not in any way connected with him, or known by him. We have much pleasure in giving publicity to this disclaimer.

ELECTRIC LIGHTING NOTES.

Aberdeen.—Mr. Blackman has resigned the position of electrical engineer to the Council, he having secured an appointment as electrical engineer to the Poplar Board of Works. A successor is to be advertised for at £225 per annum.

Asylum Lighting.—The Richmond District Asylum electric lighting scheme is not to be proceeded with until it is known when the Dublin Corporation new electricity works will be likely to be ready.

Bangor.—The Lighting Committee has reported that as the area of the fields adjoining the gas works was too restricted for the erection of electric light works, gasometer, and offices combined, and would not allow of any extension in the future, if found necessary, it is highly advisable that the land adjoining the gas works should be devoted to gas business only, and that the electric lighting works be erected on land at the corner of Dean Street. They advised the purchase of a site there, and Lord Penrhyn had expressed his willingness to sell the land to them. The Council had a discussion on the point, and finally the minutes were adopted.

Bath.—The Electric Light Committee has purchased for £90 the dynamo and 30 lamps which they had had on hire from the old company. Mr. Hammond remarked that if they had taken them over in the first place, they would have had to pay £1,950. The contractors for the new engines are arranging for their erection to be commenced on June 6th, and the first set of new plant, it is anticipated, will be ready by July.

Bethnal Green.—The Vestry has been advised on the electric lighting question by Prof. Robinson, who foresees a large measure of success for an installation. The County of London and Brush Provincial Electric Light Company's letter *re* a scheme was acknowledged by the Vestry without discussion. Prof. Robinson advises the Vestry to carry out an installation for 5,000 lamps of 16 C.P. This would entail a capital expenditure of £33,000, exclusive of land. Of this sum, £4,100 would be spent upon buildings, £10,500 on mains, £2,400 on house connections, and £11,500 for machinery. Prof. Robinson has no doubt whatever that the undertaking will at once prove remunerative, and he puts down the profit at the end of the first year at £200, at the end of the second year at £350, and at the end of the third year at £1,010. The charge for private consumers is put down at 6d. for the first year, and 5d. afterwards. The report says that the profits might with advantage be applied towards improving the public lighting. Two schemes are submitted. It is estimated that to provide arc lamps for 9,000 yards of main street would cost £16 per lamp, as compared with £3 8s. for the present gas lamps. A large number of standards would be displaced, and the increased cost, therefore, would be £1,090 per annum for increasing the total candle-power from 2,000 to 6,500 before midnight, and to 3,200 after midnight. If, on the other hand, two incandescent burners were substituted for the present gas burners the increased cost would be £278, and the illumination would be increased from a total of 2,750 candle-power to 7,040. The extra cost could ultimately be met out of the profit on the general supply, and extra lamps of higher power placed in important streets. The change would be advantageous, not only in the lighting, but because it would transfer revenue from the gas company to the electricity department. The professor thinks that refuse destruction would lead to a saving of nearly £1,000 a year on the present arrangement.

Birmingham.—At a meeting of the General Purposes Committee on 25th ult., the report of the sub-committee appointed to consider the projected purchase of the electric lighting undertaking was fully discussed. It was resolved to recommend the Council to accept the terms provisionally indicated on behalf of the

company in whom the electric lighting is at present vested. These terms fix the price of the £5 shares at £10 10s., their value in the open market. Apart from the price, there are various matters of detail outstanding.

Blackpool.—A Local Government Board inquiry was held at Blackpool on Tuesday regarding an application on the part of the Corporation for power to borrow a further sum of £40,000 for electric lighting extensions. Mr. Quinn, the electrical engineer, said that the £40,000 would only meet immediate demands, and if the demand for the current continued, another £40,000 would be asked for.

Bolton.—At the monthly meeting of the Town Council on Wednesday, Councillor Panton, as chairman of the Electricity Committee, called attention to a report of the engineer (Mr. Arthur Ellis), in which that official recommended a change from the alternating system to the continuous current for the central portions of the town. The subject, he said, was of considerable importance, and he was prepared to have the matter referred back, so that members of the Council might be placed in possession of the report and the estimates. He added that one of the advantages in changing would be that the loss in generating would only be 10 or 12 per cent. as against 25 to 30 per cent. under the alternating system. Another advantage was, that they would be able to extend and supply power for all purposes. The matter was referred back, so that the chairman's suggestion might be carried out. In his report the engineer says that the question of extensions for the coming year has had his careful consideration, and he is firmly of opinion that it is not advisable to extend on the present system, but to adopt the continuous current for the central portions of the town. By this means they will get rid of a great source of trouble and danger, as well as a great loss in the transformers, by being able to run direct from the works to the consumers' premises, with nothing in between to go wrong. In regard to the proposal to use electricity for tramway traction, Mr. Ellis lays emphasis on the fact that, by changing to the continuous current, the lighting plant could be so utilised for this purpose, the plant being made interchangeable. This would mean that the Corporation would not have the same amount of spare plant idle. The Electricity Committee have approved of the recommendations.

Bray.—A number of electric lights are to be placed along the sea wall marine promenade for the ensuing season.

Brighouse.—Mr. J. W. Garside, Brighouse, has been appointed electrical engineer to the Town Council.

Bulawayo.—On April 21st the new lamps on the suburban stands were lighted for the first time. The current is now kept on all night. The electric light company is now putting meters in the houses of all consumers, and when these are all installed the charge will be 2s. per Board of Trade unit, a reduction of 25 per cent. There are now some 800 private lights being used in the town, and 65 street lights. Only one dynamo is being used, the other being kept in reserve for emergencies. The engines are by Macintosh and Seymour. About six tons of red wood, supplied by the Timber Supply Company, are burnt nightly, which fuel is delivered alongside the building on Willoughby's special siding. It has been proved that "mapani" wood is no good as fuel.

Canterbury.—The Corporation has received a considerable number of orders for the installation of the electric light. The laying of the mains is being rapidly carried out, and it is expected that the public lighting will be completed by November.

Cardiff.—The Lighting and Electrical Committee decided on 26th ult. to reduce the prices for current from 6d. per unit for the first two hours, and 3½d. per unit afterwards, to 6d. for the first hour, and 3d. per unit afterwards. Increased consumption is expected to well make up for the consequent reduction in revenue.

China.—The *London and China Telegraph* says that Yang, a Taotai, has been commissioned to manage the electric light department for the Chinese Bund. He has obtained $10,000 from the Shanghai Taotai's Treasury for the purchase of machinery, and also the assistance of a military official in the management of affairs.

Conway.—On Thursday last week the Mayor of Conway and several members of the Cowlyd Water Board, with Mr. Marks, of Llandudno, as professional adviser, visited the board's property of the Turbine, near Cowlyd Lake, to report as to utilising the water power for the purpose of generating electricity. The Mayor stated that the result of the inspection quite warranted the action of the board, and that the property is likely to lead to important developments.

Croydon.—The Local Government Board has sanctioned loans for the electric lighting extension.

Darwen.—On 25th ult. a Local Government Board inquiry was held *re* the proposal to borrow £30,000 for electric lighting.

Derby.—The borough electrical engineer having written to the Guardians asking them to consider the advantages to be secured by using electric lighting at the Workhouse, the matter has been referred to the House Committee.

Dundee.—The Gas and Finance Committees have reported that in the electric department there has been a surplus of £1,328 4s. 3d. The charge for current up to 20 units is to be reduced from 7s. 6d. to 6s. 8d., and the supply above 20 units will be charged at the rate of 4d., being ½d. under last year's price. Current for power purposes will be supplied at 2½d. per unit.

Gloucester.—At the last meeting of the City Council the electric light question again came up for discussion. The installation has some time ago been decided upon, and plans for the works, together with dust destructor, were drawn up by Mr. Hammond and approved. The site was the chief difficulty, and this was the matter which occupied the Council's attention last week.

Hampstead.—Last week Mr. A. P. Johnson, the clerk, reported to the Vestry that the profits on the electric lighting undertaking for the past year had exceeded all expectations. The revenue for the year amounted to £8,081 0s. 9d. They had paid £2,980 8s. 3d. interest on capital, and they had also repaid £1,187 12s. 10d. instalments of capital, leaving the net profit £3,905 3s. 4d. Sir Henry Harben, the chairman, pointed out that, if the Vestry were a trading corporation, and had not to repay the capital by instalments, the profits for the year to rank as dividends would exceed £5,000. The total amount of capital expended up to the present is £100,167.

The Vestry has resolved that, "in view of the fact that the electric arc lighting of Haverstock Hill, Rosslyn Hill, High Street, and the southern portion of Heath Street is now satisfactorily completed, the Lighting Committee be instructed to bring up a report as early as possible upon the question of lighting Heath Street, north of its junction with High Street, by means of electricity, such question having been deferred by the Committee from December 13th last."

Hotel Lighting.—The order for the complete plant and wiring of the St. Anne's Hotel, St. Anne's-on-Sea, has been given to the National Electric Free Wiring Company, Limited, who have also secured the orders for the wiring of Jones's Hotel, Suffolk Street, S.W., and the residence of Mr. Ernest Franklin, 50, Porchester Terrace, W.

Hull.—There has been considerable delay in the completion of the Sculcoates Lane electricity station, but it is probably to be finished early in July. The chairman and deputy-chairman of the Electric Lighting Committee and the electrical engineer are to attend the Municipal Electrical Association Convention next week. The mains are to be extended in certain thoroughfares. With regard to the subway proposed to be erected by the Gas Committee under Queen's Dock Basin, the electrical engineer advises that owing to the distance from the line of main feeders, it would not be advantageous to the Electric Light Committee to join in the affair.

Kilmallock.—This small Irish town, having a population of about 1,000, is lighted electrically. Mr. J. J. O'Sullivan, J.P., who some years ago had an installation put down for lighting his mineral water factory, has now lighted the business houses and streets. There are nine public lamps. The plant was supplied by the Edison & Swan United Company, and consists of an 18-H.P. horizontal engine and a dynamo giving 60 amperes at 200 volts.

Lancaster.—The budget on the electric light department of the Lancaster Corporation, as presented at the monthly meeting on Wednesday, May 25th, was considered to be very satisfactory. The committee reported a profit of £598 7s. 2d. on the year, and Mr. Johnson, the engineer, submitted the comparative statement for the years ending March 25th, 1897, and March 25th, 1898, as follows:—

CURRENT SOLD, &c.

	March, 1897.	March, 1898.
Current supplied to public lamps ...	20,580	26,752
" " private consumers	85,545	120,423
" " used at works ...	2,925	3,344
	109,050	150,519

Generation of electricity.	March, 1897. £ s. d.	Cost per unit. 1897. Pence.	March, 1898. £ s. d.	Cost per unit. 1898. Pence.
Coal, oil, waste, water and sundries...	472 15 3	1·04	581 0 7	·92
Wages at generating station	332 10 5	·73	371 1 9	·59
Distributing	25 1 5	·05	22 12 1	·03
Public lamps	67 16 1	·14	69 2 11	·11
Rents, rates, royalties ...	121 1 10	·26	96 19 11	·15
Management, salaries, and sundries...	174 5 4	·38	194 17 1	·31
	1,193 10 4	2·60	1,835 14 4	2·11
		...		·49 decrease.

INCOME.

	March, 1897. £ s. d.	March, 1898. £ s. d.
Sale of current, less discounts ...	1,710 10 8	2,382 9 10
Rent of meters	119 6 9	1 9 3
Public lighting	384 13 7	504 19 6
Miscellaneous	12 10 0	13 0 0
	£2,227 1 0	£2,901 18 7

Mr. Clough (the borough accountant) reported that the electricity department has made considerable progress, the balance transferred to the district fund being £510 in excess of the previous year. The financial results, so far, have been:—

	£ s. d.	£ s. d.
Loss 1894-5	373 11 7	
„ 1895-6	539 8 11	
		913 0 6
Profit 1896-7	87 19 8	
„ 1897-8	598 7 2	
		686 6 10
Net loss		226 13 8

It was estimated that there would have been a profit on the year amounting to £260 1s. 6d., and it is pleasing to have to report that this department has done better than anticipated. The comparative figures are as follows, shillings and pence omitted:—

	1895-6.	1896-7.	1897-8.
Income:—	£	£	£
Sale of current, less discount ...	1,337	1,795	2,494
Rent of meters...	87	119	1
Public lighting...	366	384	504
Sale and repairs of lamps, &c. ...	352	248	273
Expenditure:—			
Manufacture of electricity	919	805	952
Dist. and management...	611	447	480
Rents, royalties, and taxes	52	97	84
Debt redemption, interest on loans, &c., or contribution to stock dividends account	992	992	992

Capital expenditure upon the electricity works amounts to £24,211 4s. 4d. The increase during the year was £1,313 16s. 2d., but the premiums obtained on the Corporation 3 per cent. redeemable stock, less compensation to mortgagees, brought forward from last year, reduces this amount by £319 17s. 9d. Amount set aside for redemption of stock during the year was £831 9s. 3d., and the liability on March 25th amounted to £24,680 2s. 4d., the same as the previous year. Mr. Hall moved the confirmation of the minutes of the Electricity Committee, drawing attention to the large increase of electricity during the year, which the Committee were prepared to meet by putting down fresh plant. The comparative statement was well worth considering, because it showed at once the large increase in the consumption of electricity. The cost of production was very favourable indeed in comparison with other low tension stations in the country. He believed they stood the highest in England under the low tension system in regard to the low price at which they produced electricity. He hoped they would be able to keep that position. Mr. Heald seconded, and the minutes were confirmed.

Leigh.—The District Council has decided to apply to the Local Government Board for sanction to borrow various sums, including £10,500 for proposed electricity works.

Liverpool.—The Lighting Committee has resolved upon extension of mains in several thoroughfares at a cost of nearly £700.

London.—At last week's Court of Common Council Mr. Brooke Hitching asked the chairman of the Streets Committee if the law officers had reported on the reference as to whether the Corporation was able to erect and maintain a municipal electric lighting station, having regard to the agreement which had been entered into by the Corporation with the City of London Electric Lighting Company; and further, whether the law officers were unanimous in their opinion that the erection of such a station would be a breach of the agreement in question. No reply to the question was forthcoming.

The Board of Trade has issued provisional electric lighting orders to the Bermondsey and Marylebone Vestries for the whole area of their respective districts.

Mauritius.—Mr. F. J. Warden-Stevens has been appointed to prepare a scheme for the electric lighting of Port Louis, Mauritius.

Morecambe.—At a special meeting of the District Council on May 23rd, Mr. Krauss (the contractor for the installation of electric lamps and pillars on the Promenade), wrote asking to be allowed to put up the arc lamps and pillars on the Bare Promenade. The Council refused, informing Mr. Krauss that the time had already passed when, under his contract, he should have handed over the Promenade to the District Council, completed. The delay was causing them considerable inconvenience, for which they held him responsible. Notice was given to Mr. Krauss that the Council would themselves proceed to lay the cables and put up the arc lamps and pillars after 14 days from that date.

Pembroke.—A Local Government Board inquiry is to be held to-morrow, June 4th, regarding the Township's Commissioners' proposal to raise £33,000 for electric lighting.

Poplar.—The Board of Guardians has adopted a report of its Electric Lighting Committee with reference to the hot and cold water and steam supply at the workhouse, and embodying schemes for lighting the workhouse and the offices at North Street by electricity. Mr. Warden-Stevens' original scheme was adopted, and he has been instructed to prepare the necessary plans and specifications. Application is to be made to the Local Government Board for a £9,000 loan for the purpose.

Portsmouth.—The balance-sheet and revenue accounts of the Electric Lighting Committee for the year ending March 31st last, which was issued on Thursday last week, shows total receipts amounting to £16,265 3s., and an expenditure of £9,469 13s. 9d. This leaves a gross balance of £6,795 9s. 3d. on the year's working. Of this sum the Committee carry £6,750 to net revenue account, leaving a balance of £45 9s. 3d. to be carried forward. Out of the £6,750 the Committee have paid £3,180 19s. 4d. for interest of borrowed capital, and £2,793 13s. 7d. towards redemption of loans. No sum is written off to provide a reserve fund to maintain and renew the machinery.

Provisional Orders.—The electric lighting provisional orders relating to Batley and Ossett were confirmed in the House of Commons on Monday last week.

Saltburn.—Messrs. Burstall & Monkhouse are preparing a report on electric lighting for the District Council. There are two schemes—one promoted by the Cleveland and South Durham Assets Company, and the other by the Urban Council.

Shoreditch.—Mr. C. N. Russell, the chief electrical engineer, has issued a list of streets in which the Vestry's supply mains are laid, or will be laid within the next few weeks. The list is as follows, the mains in some cases being laid on one side, and in others on both sides of the street:—Bateman's Row, Brunswick Place, Cropley Street, City Road, Commercial Street, Curtain Road, Charlotte Street, Charles Square, Church Street (to boundary), Calvert Avenue, Coronet Street, East Road, Eagle Wharf Road, Great Eastern Street, Garden Walk, Hackney Road, Hoxton Street, Hoxton Square, High Street (to boundary), Holywell Lane, Huntington Street, Kingsland Road, Leonard Street (Sq. to boundary), Motley Street, New North Road (from East Road to Eagle Wharf Road), New North Road (Pitfield Street to East Road), New Inn Yard, Nile Street, Old Street (from City Road to Pitfield Street), Old Street (Pitfield Street to High Street), Paul Street and Wilson Street, Pitfield Street, Rivington Street, Rufus Street, Sun Street, Shepherdess Walk, Tabernacle Street (to boundary), Wenlock Street, Worship Street, Ware Street.

Tunbridge Wells.—It is stated that the surplus for the year ending March 31st on the electric light undertaking at Tunbridge Wells is close upon £2,400.

Twickenham.—The District Council have had laid before them proposals by Edmundson's Electricity Corporation, of Broad Sanctuary Chambers, Westminster, to light the town by electricity. The Corporation offer to form a local company, free of all expense to the Council, to light the districts of Twickenham and Teddington by electricity. They would consent to the inclusion in the order to be obtained from the Board of Trade of a clause that light to be used for the streets or public buildings should be supplied at 3d. per unit, for private dwellings 7d. per unit, and that the Council should have the option of taking over the undertaking at the end of 14 years. The communication was referred to a special committee, but members expressed the view that the Council should be careful how they tied themselves down, for there might be a time coming when they could destroy dust and manufacture electric light at the same time.

Wandsworth.—The Board of Works has given consent to the application of the County of London and Brush Provincial Company to lay mains in Lower Richmond Road, Putney.

Westgate.—On 21st ult. Major Cardew, R.E., resumed the public inquiry opened on the 13th ult. in the matter of the application by the Isle of Thanet Rural District Council for a provisional order. A good deal of evidence was given, and the Major said he would report in due course.

Whitechapel.—We learn that the District Board, on 24th ult., decided to lay down its own electric light installation for the district.

Wimbledon.—It is expected that the electricity works will be completed about March next year, and the District Council is inviting intending consumers to lodge their applications for current. Mains will be laid in every street.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birmingham.—The report of the Public Works Committee recommends the City Council to adopt overhead electric traction upon the Sparkhill and Small Heath routes. There has been a serious divergence of opinion in the committee with regard to this proposal, which was only adopted by the bare majority of one, five being in favour of permission being granted and four against. It should be understood that the committee still retain their favourable opinion towards the conduit system, but the utter inability to come to terms led to such a deadlock that they felt compelled to adopt some other means of settling the difficulty, which, in its quiescent state, was causing the public no small amount of inconvenience. On the routes mentioned there was a strong growing feeling of antipathy towards the steam trams, and in view of this the larger half of the committee supported the proposal the Council will be asked to adopt. It must be clearly understood, says the *Birmingham Post*, that this is merely a four years' trial of the overhead system, which has been adopted in several places where the tramways have been municipalised. If, at the end of that period, the overhead method does not meet with the approval of the Corporation, we understand the company have undertaken to remove it at their own

expense, but, in the meanwhile, members of the Public Works Committee feel strongly that the experiment in question will be preferable to the continuance of the present system. In addition to this recommendation the report includes an offer of Messrs. Dick, Kerr and Co., Ltd. The whole matter will be discussed on Tuesday next, June 7th. Messrs. Dick, Kerr's offer is for the provision of a tram service upon roads in the city along which there is at present no such accommodation. They undertake to adopt either the underground electric conduit or the cable system of traction as may be found suitable to the various routes; they stipulate that the term of concession must be for 21 years, and agree that if the Corporation purchase the business of the Birmingham Electric Lighting Company, as is proposed, they will become customers for their electric power. In lieu of rent a profit-sharing arrangement is suggested, contingent upon paying 5 per cent. interest upon the capital of any company that may be formed, and the laying aside of a sufficient annual sum to provide for a sinking fund for the whole of the capital. Finally, at the expiration of the term of concession the whole of the lines within the city would revert to the Corporation without payment. It is understood that the chairman of the Tramways Company does not now adhere to his recent statement that the Corporation had given verbal permission to instal the overhead trolley system in certain parts.

Brierley Hill.—Last week the first sod was turned at Round Oak in excavating the foundations for the power station of the British Electric Traction Company.

Dublin.—Early last Friday morning a successful trial trip was made on the newly completed section of the electric tram line between Haddington Road and Nelson's Pillar. Mr. Astrom, the electrical engineer of the Dublin United Tramways Company, accompanied by other officials of the company, ran one of the motor cars from Haddington Road into O'Connell Street *viâ* Merrion Square, Westland Row, Great Brunswick Street, and D'Olier Street, This section was to be open for traffic this week. In this line centre poles are placed throughout the entire distance, but otherwise the installation is exactly the same as that on the Clontarf section. The Board of Trade inspection was expected to take place this week. The electrical equipment of the various other lines is proceeding rapidly. Poles are now being erected along the north quays, where the cables are also being laid. The laying of the underground conduits is being pushed forward rapidly all over the city. The great central power station at Ringsend is progressing quickly. Already the foundation excavations have been made, and the work of erection commenced. The line connecting Rathmines with the sea is now almost constructed. Pending the electrical equipment of this line, which will be shortly taken in hand, it will be worked, says the *Dublin Nation*, by horse haulage.

Dudley.—The contract for the new electrical power station at Brierley Hill has been secured by Messrs. J. H. Whittaker and Co., Dudley. The contract amounts to £7,000. The work has to be completed in about four months.

Glasgow and Paisley.—A sub-committee of the Upper District Committee recently had a conference with the Glasgow Tramway Committee *re* the proposed construction of electric tramways in Paisley and district. The members of sub-committee, having considered the proposals by Glasgow, resolved to report that, in their opinion, it would be preferable to enter into an arrangement with the Glasgow Corporation in connection with the construction of tramways on the Paisley Road, rather than with the British Electric Traction or other private company, who, moreover, it is understood, propose to lay, in the first instance at least, only a single line of rails on the road, to which the sub-committee entertain the strongest objection. The sub-committee also resolved to request a conference with representatives of the burgh of Paisley regarding the proposal of the British Electric Traction Company to construct a tramway on the Leith Road, between the burghs of Paisley and Johnstone, to be held either at Glasgow on Wednesday, 25th curt., or at Paisley on Thursday, 26th curt., as may be most convenient for the Paisley representatives.

Gorton.—The Electric Lighting Committee has been considering the Manchester Corporation's proposal regarding the working of the tramways. The proposals were that the authorities in the out-townships should acquire the lines in their respective districts, and provide electric energy and the necessary equipment for the working of the tramways on the same system and at the same voltage as proposed to be adopted in Manchester, at their own cost. Such an arrangement, if agreed upon, was subject to a revision at the end of three years' working. The Committee, whose proceedings were confirmed by the Council, decided not to accept the proposals. The chairman of the General Purposes Committee and the clerk subsequently met representatives of the Denton District Council and the British Electric Traction Company. Arrangements have been made for a conference to be held at an early date between the members of the Gorton Council and the representatives of the district upon the Lancashire County Council.

Helston to Lizard.—The Board of Trade has issued the modified and now confirmed order made by the Light Railway Commissioners authorising the construction of a light railway, commencing by a junction with the Helston line of the Great Western Railway at its termination, and terminating at the Lizard, a distance of over 11 miles. Clauses are inserted to enable the company to work the line by steam, mechanical, or electric power.

Kew Bridge.—The Middlesex County Council at its meeting on Thursday last week, resolved to oppose the proposals of the London United Tramways Company to carry electric trams over Kew Bridge. They, however, acknowledged the receipt from the joint Kew Bridge Building Committee of the following recommendation:—"That it be a recommendation to the County Councils of Middlesex and Surrey, that a double line of tramway be allowed over the proposed new bridge, subject to the tramway company paying the whole cost of the widening of the proposed bridge and its approaches, in accordance with the suggestion of Sir John Wolfe Barry, and subject to other conditions being satisfactory as regards the method of working, maintenance, and in other respects."

Kirkcaldy.—Prof. Kennedy has been collecting further information locally for completing his report on the proposed electric light and traction scheme.

Leeds.—On Tuesday night a guard wire broke when a car was running along North Street toward Briggate.

Llanfair and Beaumaris.—The Light Railway Commissioners have come to the decision, respecting the above line, that they would not be justified in submitting to the Board of Trade an order authorising the construction of the line. The decision has caused the greatest disappointment in the Menai Bridge and Beaumaris and Llandegfan districts, through which it was intended to run the line.

Middlesborough.—The Streets Committee on 27th ult. discussed the laying of the track for the new electric tramway service, the ground of complaint being that the scored brick paving was considerably above the level of the rails. At a previous meeting a resolution was passed allowing three months in which to give the bricks opportunity to settle, upon an undertaking that if at the end of that time they were not level with the rails the company would make them so. Last week it was resolved that the former resolution be rescinded, and that the Corporation consistently oppose the granting of the license till the pavement is made on a level with the rails.

Rochester, Chatham and Gillingham.—The Light Railway Commissioners will continue at Chatham, on Monday, June 6th, their adjourned public inquiry into the application which has been made by the Rochester, Chatham, Gillingham and District Electric Railways Company, Limited.

Southall.—The District Council last week considered the proposals of the company in regard to its application for an order to construct a light electric railway in the Council's district. On Friday last the Council interviewed Mr. George White, chairman of the London United Tramways, Ltd., and Mr. J. Clifton Robinson, managing director, and subsequently decided *nem. con.* to sanction and approve the scheme on the following conditions: That the pattern and positions of the trolley wire standards be approved by the Council; that the company wood-pave its track through the High Street (about a quarter of a mile); that the fares be no more than 6d. from Shepherd's Bush to Uxbridge, 4d. from Shepherd's Bush to Southall, and 2d. from Southall to Uxbridge, workmen's fares to be not more than half the ordinary fares; and that the Council have the use of the trolley wire standards for lighting or other purposes.

Southend.—The Corporation of Southend-on-Sea have just let a contract to Messrs. Alexander Penney & Co., of London, for the provision of a siding and passing place in connection with the electric tramway on the pier. This has been necessitated owing to the almost phenomenal growth of the traffic on the tram. The whole length of this tramway is one mile. It has a gauge of 3 feet 6 inches, and the weight of the rails is 45 lbs. per yard. These are secured to wooden longitudinal deck beams by steel clips and ⅞th inch coach screws. The joints of the rails consist of ordinary fish-plates and bolts with copper strip bonds. The line is straight with equal forked siding at the pier head. The power station is arranged under the pier entrance. It is provided with a 12 H.P. horizontal engine and locomotive type boiler by Messrs. Davey Paxman & Co., of Colchester. There is a Crompton dynamo of 200 volts giving out 100 amperes. The current is carried direct from the dynamo along a centre rail, the car rails taking the return current. The traffic is worked by means of three trains, each consisting of a like number of open or summer cars. The motor car is fitted with a Crompton 10 H.P. motor geared by means of a phosphor bronze spur gearing on the hind axle. In the busy season a 15-minute service is worked, and, of course, with the extra facilities provided by the new siding and passing place the service will be accelerated. This work, it is expected, will be completed in two or three weeks' time. Messrs. Penney are also building an improved tram of three cars. The speed is limited to 8 miles per hour, and the line appears to admirably answer its purpose. The traffic is well managed by Capt. Kelly, whilst the machinery is under the control of Mr. Frank Norton; Mr. F. H. Gill is in charge of the new works, and Mr. E. Martin is resident engineer.

The Spen Valley.—The proposal to construct an electric tramway in the Spen Valley of Yorkshire has speedily taken shape, and before long some definite steps will in all probability be taken. As a result of the visits paid to the district by a representative of the British Electric Traction Company a letter has been received by the various authorities concerned, in which the company says that it proposes to take the necessary preliminary step with a view to obtaining the necessary powers for constructing an electric tramway connecting Ravensthorpe, Dewsbury, Staincliffe, Heckmondwicke, Liversedge, and Cleckheaton. "We propose to proceed under the Light Railways Act, 1896, as," adds the company, "under this Act by the local inquiry held by the commissioners better facilities are afforded to the local authorities for the discussion of the whole question than is the case under the Tramway Act. Under this Act

the application can be made in November next and the intervening time will give us ample opportunity to discuss the whole details of the scheme with you." The letter has not been discussed by the authorities yet, but it has been relegated to the various committees. The line will be some 12 or 13 miles in length.

Sunderland.—The Council has adopted a report of the Tramways Committee, recommending that a deputation be appointed to visit Hamburg, Brussels and Leeds, and to report to the Council upon the systems of electrical or mechanical traction in vogue there.

Surrey and Middlesex Light Railways.—The opposition which from the first was displayed in Richmond towards the London United Tramway Company's proposed light railway over Richmond Hill to Kingston has not in any way diminished. Other local authorities have followed the lead of the Richmond Town Council in giving notice of intended opposition. The Ham District Council at their last meeting discussed the proposal, and came to the conclusion that the railway would be of no benefit to Ham, and it would be an obstruction to traffic, that it would be dangerous owing to the steep gradient running down through Petersham Wood from Richmond Hill, and that the narrowness of the roads at places would increase the danger. The result of the debate was the passing unanimously of a resolution to oppose. At the Kingston Town Council the points urged against the proposal were that light railways were intended for agricultural districts, not for towns like Richmond and Kingston, that no provision was made for the purchase of the undertaking by the Corporation, that a monopoly should not be tolerated in the borough, that it would injure the residential district, that there would be danger on the roads, that the district was well served in means of communication, and that if tramways were wanted the Corporation should provide them. It was also argued that the Town Council should oppose with a view of getting roads widened, and particularly securing the reconstruction of of Kingston Bridge over which the line would pass into Middlesex. A recommendation to oppose was unanimously agreed to. At the meeting of the Middlesex County Council also it was agreed without discussion to oppose the order, inasmuch as it related to the County of Middlesex.

Swansea.—The British Electric Traction Company, into whose possession the Swansea Tramways recently passed, commenced on Tuesday to relay the system and to equip it for electrical traction.

TELEGRAPH AND TELEPHONE NOTES.

The Alternative Cable to the Cape.—In the Legislative Assembly at Cape Town last Friday, Sir J. Gordon Sprigg intimated, that, subject to the approval of Parliament, the Government agreed to construct the land wires for the "all British cable from England to Australia," and that subject to a reduction of cable rates the Government favoured a further subsidy to the Eastern Telegraph Company. Mr. Merriman pointed out that Mr. Hofmeyr was in favour of the proposition that the cable should be owned by the Cape and the Imperial Governments, thus abolishing the company's monopoly. The matter will come up for discussion at an early date. In the meantime we learn that the cable steamer *John Pender* is about to sail from the Cape for England, with instructions to take soundings along the proposed cable route on her voyage home. The length of the proposed cable will be about the same as that projected across the Pacific, and, judging from the few soundings already taken on the southern portion of the proposed line, the depths should be about the same as those found in the Pacific along the intended cable route. It is to be hoped that the survey by the ss. *John Pender* will not occupy so long as the cable route survey still being carried on by the Admiralty across the Pacific, which has been going on for about ten years. There is some talk of extending the Cape cable on to Australia; but this idea does not meet with much encouragement from the Australian Premiers. At the Hobart Conference it was pointed out that there was no willingness shown by the telegraph companies to reduce rates to the public, in spite of the fact that last year alone, which was a year of reduced traffic, the money collected was £50,000 in excess of the guaranteed amount, yet the company was only prepared with a concession amounting to about £4,000, which was wholly inadequate. In view of the large subsidies the company had received during the past 20 years it would have been reasonable to have offered to take public messages at 4s., which would have reduced the company's takings to about the guaranteed amount. The company was disinclined to do anything except on the understanding that the colonies entered into the new project of an alternative route *viâ* the Cape. Unless it could be shown that the Cape route afforded Australia advantages beyond strategic and sentimental ones from an Empire point of view, the conference could not recommend the respective colonies to accept the arrangement. That was the view taken at the meeting of premiers. They would not subsidise the Cape cable. The better alternative route would be *viâ* Canada. He moved—"That in the absence of a satisfactory proposal from the E.E. Company and of any proposals at all except on the basis of an alternative cable *viâ* Africa, this conference is unable to make any fresh arrangement with that company." Mr. Duffy seconded the motion. He said no company must be allowed to fetter Australia with a monopoly. The motion was put and passed. Mr. Dickson advocated the Pacific cable route as tending to reduce charges and be all in British territory. He moved a motion in favour of that consummation as speedily as possible, and communications be made with Canada and England, that if they will contribute one-third each Australia would give the other third. Mr. Duffy seconded. The motion was put and passed.

The New Gotland Cable.—Messrs. W. T. Henley's Telegraph Works Company completed the laying of this cable, connecting Gotland with Sandon, Hufvudskor, Ornon, and Dalaro on the 1st inst. The cable steamer *H. C. Oersted* returned to Copenhagen the same evening.

The Pacific Cable.—The *Times* Ottawa correspondent says that on the 26th ult. a discussion took place in the Canadian House of Commons on the Pacific Cable question. Members on both sides of the House urged the Government to endeavour to push forward the project. Sir R. Cartwright, for the Government, said that the people of Canada were far less directly interested in the project than the Australasian colonies; and, as the Imperial authorities had contributed heavily to Imperial projects by constructing the Canadian Pacific Railway of Canada, he thought they should not be asked to contribute beyond a reasonable share. The negotiations had not resulted in action, yet the Government has not abandoned the hope of a successful issue.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Gurupa ...	April 4th, 1898 ...	
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Bolama-Bissao	April 12th, 1898 ...	...
Maranham-Para	„ 17th, 1898 ...	...
Hong Kong-Manila	May 3rd, 1898 ...	...
Zanzibar-Mombassa ...	„ 18th, 1898 ...	May 31st, 1898
LANDLINES.		
Trans-Continental line beyond Masol	March 12th, 1898 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Majunga-Tananarive ...	May 23rd, 1898 ...	May 25th, 1898
SIBERIAN LANDLINES.		
Djalinda-Blagowestchensk ...	May 27th, 1898 ...	May 28th, 1898

The Telephone Agitation.—The conference between the London County Council and representatives of Metropolitan local authorities has been postponed till June 10th. The Select Parliamentary Committee will meet again on Tuesday next, 7th inst., and continue the examination of Mr. J. C. Lamb, C.B.

Telephones in Switzerland.—There are some interesting remarks on the success of the telephone system under State management in the latest Swiss Consular report. The number of members on the Berne Exchange is 2,025, the subscription being originally fixed at £4 16s. for the first year, £4 for the second, and £3 4s. for the third and subsequent years, the subscriber being entitled to 800 messages per annum. The rates, says a financial contemporary, have since been reduced to £4, £2 16s. and £1 12s. respectively, with an additional charge of 5 centimes (½d.) for every message. The number of central stations is 225, and the total number of stations, counting the dwellings or offices where instruments for the use of subscribers are placed, amounted to 23,671.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—June 6th. The Harbour Commissioners are inviting tenders for the supply of three belt-driven, continuous current, series wound dynamos, to give 15 amperes, 2,850 volts, at 800 revolutions per minute, for 18 hours' continuous running without undue heating. Harbour engineer, Mr. G. F. L. Giles, from whom particulars may be obtained. See our "Official Notices" May 27th.

Belgium.—June 10th. The Provincial Government Authorities in Brussels are inviting tenders for an installation of electric lighting in the Bibliotheque Royale, in the Place du Musée, Brussels. Tenders to be sent to Le Gouvernement Provincial, Rue des Augustins, 17, Brussels, from whence particulars may be obtained on payment of 4s. 6d.

Bournemouth.—June 20th. The Corporation is inviting tenders for the supply, &c., of cables, arc lamps, incandescent lamps, wiring, switchboards, fittings, &c.; also steam dynamo, &c. Particulars from the borough engineer, Mr. F. W. Lacey, also see our "Official Notices" May 27th.

Bury St. Edmunds.—June 13th. The Corporation invites tenders for the supply and erection of Lancashire boilers, three 60-kw. steam dynamos, transformer and booster, accumulators, street mains, and various other machinery and apparatus for the electricity undertaking. Consulting engineer, Mr. F. H. Medhurst, 13, Victoria Street, S.W. See our "Official Notices" May 13th.

Coventry.—June 7th. The Electric Lighting Committee invites tenders for electric mains, switchboards, arc lamps, posts and apparatus in connection therewith. For particulars of the several sections see our "Official Notices" May 13th. Mr. Gilbert S. Ram, city electrical engineer.

East London (Cape Colony).—June 28th. The Town Council is inviting tenders for erection of buildings and the supply of electric lighting machinery, electric tramcars, plant, rails, &c., and for their maintenance for six months from completion. Particulars from Messrs. Dyer & Dyer, 17, Aldermanbury, London, E.C., on payment of £5, repayable on the receipt of a *bond fide* tender.

Edinburgh.—June 14th. The Corporation wants tenders for the electric wiring of the police chambers (400 lamps). Particulars from the electrical engineer, Dewar Place, also see our "Official Notices."

Hammersmith.—June 8th. The Vestry is inviting tenders for the supply and erection of a Ledward evaporative condenser and tanks, air pump, circulating pumps, and pipe work. Consulting engineer, Mr. A. H. Preece. See our "Official Notices" May 27th for particulars.

London.—June 21st. The London County Council is inviting tenders for engines, dynamos, accumulators, switchboards, feeders, distributors, and service mains and all accessories, to be fixed complete in buildings at the Crossness Outfall Works, near Erith, Kent. The L.C.C. also requires tenders for providing and fixing cables, wires, conductors, casing, pendants, brackets, and other fittings, columns, lanterns, lamps, switches, and switchboards, distributing boards, fuses, cut-outs, &c., necessary for the lighting by electricity of the Crossness pumping station and works, near Erith, Kent. Particulars of both contracts from the Engineer's Department, County Hall, Spring Gardens, S.W. See also our "Official Notices" May 27th.

Sheffield.—June 13th. The Tramway Committee is inviting tenders for the erection of an electric power station for its tramway scheme. Particulars from the City Surveyor.

Southampton.—June 20th. The Corporation invites tenders for the supply and erection of lamp columns, arc and incandescent lamps, automatic switches and fittings. Consulting engineers, Messrs. Kincaid, Waller & Manville. See our "Official Notices" this week.

St. Mary, Newington.—June 6th. The Vestry Electric Light Committee is inviting tenders for the supply and erection of engines, generators, and public lighting plant for the electric lighting scheme. Engineers, Messrs. Kincaid, Waller & Manville.

St. Pancras.—June 14th. The Vestry wants tenders for condensing plant, steam pipes, &c., for the Regent's Park electricity station. Particulars from the chief clerk, Electricity Department, 57, Pratt Street. See our "Official Notices."

Taunton.—June 6th. The Corporation invites tenders for the supply and erection of engines and alternators in exchange for existing alternators and transformers, also alterations to switchboard, supply of rectifiers, &c. Messrs. Kincaid, Waller and Manville, engineers.

Tynemouth.—June 20th. The Corporation wants tenders for the supply of steam dynamos, balancer and boosters, &c. Consulting engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices" this week for particulars.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

Watford.—June 8th. The District Council is inviting tenders for the erection of an electric light station adjoining the new sewerage works. Particulars from the architects, Messrs. Gordon, Lowther & Gunton, Finsbury House, Bloomfield Street, E.C.

CLOSED.

Belfast.—The Corporation has accepted the tender of Mr. W. H. Drennan for wiring the new police office and cells for electric lighting.

Southampton.—The City Council has accepted the tender of Mr F. Osman for trenching and laying conduits for electric light mains, at £1,029 odd. The other tender received was from Messrs. Reid Bros., £1,280.

FORTHCOMING EVENTS.

1898.

Wednesday, Thursday, Friday, and Saturday, June 8th, 9th, 10th, and 11th.—Municipal Electrical Association Conference. See our "Notes" last week.

Friday, June 10th, at 8.30 p.m.—The Institution of Junior Engineers at the Westminster Palace Hotel. Special meeting to welcome Sir T. Salter Pyne, C.S.I., honorary member of the Institution.

At 5 p.m.—Physical Society. Agenda:—1. Exhibition of a Model illustrating Dr. Max Meyer's new theory of Audition, by Prof. S. P. Thompson, F.R.S.; 2. "Attenuation of Electric Waves along a line of negligible Leakage," by E. H. Barton, D.Sc; 3. "Diffusion Convection," by A. Griffiths, B.Sc.

Thursday, June 16th, at 9 p.m.—Institution of Electrical Engineers' Conversazione at the National History Museum, South Kensington.

NOTES.

Mr. C. E. Dolbear's Submarine Telegraph Tests.—The manifest necessity of establishing communication between vessels at sea and the shore in time of war has induced numerous inventors to try methods for accomplishing this end. Of the electrical methods tried, says the New York *Electrical Engineer*, perhaps one of the oldest, but least developed, is that of simple conduction, that is, taking advantage of the fact that a current flowing between two points not metallically connected spreads out in waves, and covers a wide area, depending upon the conducting material, the strength of the current, and distance between the terminals. To determine the relation between these quantities and the possibility of practically employing this means of communication between American vessels now stationed in southern waters, near the Florida and Cuban coasts, Mr. C. E. Dolbear, a son of Prof. A. E. Dolbear, of Tufts College, made arrangements with the New York *World* to carry on extensive experiments in the Kill von Kull, a channel of salt water between the New Jersey and Staten Island shores. 1,500 feet of No. 14 copper wire stretched along a rocky ledge between the railway station of Sailor's Snug Harbour and an old mill. The two ends of this wire were connected to copper plates immersed in the water, and a telegraph key and a number of Mesco dry batteries were placed in the circuit. After these preliminary arrangements, a party consisting of Messrs. T. A. Edison, jun., C. E. Dolbear, W. J. Clarke, Charles Cuttriss, Chas. W. Price, Max Loewenthal, O. S. Burr, W. H. Holzer, and *World* representatives, Messrs. Young and Miller, embarked on the tug *Leonard Richards* on Thursday, May 5th, to conduct the experiments across the Kill von Kull, a distance of a quarter of a mile. A wire, whose ends were connected to plates of copper inserted in the water over the bow and stern of the tug, was cut in the middle, and a telephone receiver placed in circuit. A provisional code was adopted, and signals transmitted from the shore were plainly heard by those on the tug. The experiments may be considered highly successful, and may lead to gratifying and beneficial results.

Obituary.—The death occurred on Tuesday afternoon of Sir Robert Rawlinson, the distinguished sanitary engineer. Sir Robert, who was 89 years of age, was Sanitary Engineer Commissioner of the British Army in the Crimea, and Chief Engineer Inspector of the Local Government Board.

The *Standard* also records the death of Dr. John Barrett Melson at the age of 87. He was educated at Trinity College, Cambridge, and was appointed Professor of Natural Philosophy and Hygiene at Birmingham Medical School. When lecturing at a Philosophical Institution upon physics and electro-dynamics, the late Archbishop of Canterbury and the present Bishop of Durham were among his pupils. We understand that, at the request of Sir Isambard Brunel, he calculated the lateral oscillation of engine axles, and Prof. Faraday relegated to him the question of the economical value of electricity as a motive power.

The War and the Cables.—Mr. E. W. Parsoné writes to the *Times*, from the Constitutional Club, in regard to Mr. Holland's letter on this subject, which was reprinted in our last issue. He says:—

Without doubt many interested in submarine cable property have read with interest Mr. T. E. Holland's letter published in your issue of the 24th inst., in which, after referring to the international convention for the protection of submarine telegraph cables signed at Paris in March, 1884, he says:—

"The question is a new one, but, though covered by no precedent, I cannot doubt that it is covered by certain well-established principles of international law."

This remark would lead most people to suppose that up to the present there did not exist cases of submarine cables being interfered with by belligerents. This, however, is not the case. During the Franco-Prussian war—1870-71—cables connecting places on the French coast were systematically cut in extra-territorial waters, and later, in the war between Chili and Peru, the cables of an English company connecting those two countries were cut in territorial waters, and, I believe, also in extra-territorial waters. The Chilian Government was called upon to indemnify the company for actual and indirect loss occasioned by this action, and had the claim been submitted as a whole to the international commission which sat to adjudicate claims resulting from the war, their judgment might have formed a lasting precedent for parallel cases. The Chilian Government, however, at once admitted its liability to reimburse the company for all expenses connected with the repair of the said cables, and this sum was accepted by the company in full compensation for all prejudice sustained by it. This very frank action by the Chilian Government so far as it goes should be kept in mind as forming a precedent for the liability of States which may in time of war find it expedient in their own interests to cut submarine cables or interfere with telegraphic communication by their means.

Despatches from Washington state that the cable which the scout steamer *St. Louis* cut is one of the English-owned lines between Jamaica and Puerto Rico. It is stated at Madrid that the Americans have cut the cable between Guantanamo and Hayti, which belongs to a French company.

According to the *Times* Berlin correspondent, the *Berliner Neueste Nachrichten* devotes a leading article to the question propounded in the Spanish journal *Imparcial* as to whether America has the right or not to cut submarine cables in time of war. The article says:—

There can be no doubt that Spain could inflict a very serious blow on America by the simple process of cutting the cables connecting her with Europe. Her commerce would be materially impaired. Her Stock Exchange would undergo a panic. She could not hold out three weeks were she cut off from all connection with Europe. We are astonished that Spain has not made use of this simple but effective means of warfare. Spain should remember the maxim *à la guerre, comme à la guerre*. The German law for the protection of cables has been in force since May 1st, 1888. In time of peace the cables are protected; but, on the other hand, Powers in actual state of war have a free hand to do as they please. It is another question whether compensation should be offered to those neutral Powers whose cables have been cut or in any way damaged.

Personal.—Mr. Wm. H. Marshall, who has been for two years on the technical staff of Messrs. Babcock & Wilcox, Limited, has been appointed draughtsman to the Westminster Electric Supply Corporation. Mr. Marshall was for five years assistant to Mr. Campbell Swinton.

The Electricity Committee of the Blackpool Town Council have recommended that the salary of the electrical engineer (Mr. Quin) be advanced from £300 a year to £400.

A Hitherto Unknown Cable.—We have often had occasion to draw attention to newspaper and magazine science, and the latest example of the "talented author" type may be found on page 762 of *Pearson's Weekly*. In a new serial story, "Contraband of War," a tale of the Hispano-American struggle, a party of men land to cut a cable. In five minutes someone whispered "Here it is." He pointed to *a thick rope made of many layers of netted wire, alternating with gutta-percha, which ran down a hillside, then along the sands, then dived to its dark bed within the deep*. We have inquired of every manufacturer as to the probable date of the making and laying of this remarkable type of cable, but they all disclaim any knowledge of it. Perhaps Mr. Charles Bright can enlighten us?

A Hint to English Consuls.—We reproduce the following letter from the *Scientific American*. If our consuls in foreign parts would take a leaf out of the U.S. Consul's book and send home similar reports, English electrical manufacturers would be benefited, that is, assuming that proper regard were paid thereto:—

AN ELECTRIC RAILROAD FOR FREIBURG.

To the Editor of the *Scientific American*.

The city of Freiburg, a town of 55,000 inhabitants, with most beautiful surroundings, many large villages near by, and romantic valleys into the heart of the Black Forest, is contemplating the building of an electric railroad system and a central power station for electric light and locomotive power.

Competition for these new enterprises is open to the world, and as United States consul I consider it my duty to call the attention of American manufacturers to the same, and feel that your valuable publications are the best medium for that purpose; hence send this note to you.

Freiburg is a busy little city, very conservative and slow, but sure in whatever it undertakes, and whatever is constructed here is built, not for a day or lifetime, but for an age.

"Rapid" transit they have here, but it is the old-fashioned omnibus. Electric light is seen nowhere, but in several factories with private motors and dynamos. Hence the need of these new enterprises and the call for bids for the same, such bids to be in the hands of the Committee on Underground Structures (Tief-bauamt) before July 1st, 1898.

I mail you under separate cover the circular letter, plan of the city, plans and profiles of the projected enterprises, &c., such as the above-mentioned committee sends to parties interested, and shall be glad to procure any further information for you or other Americans who may take an interest in this matter.

E. THEOPHILUS LIEFELD,
United States Consul.

Freiburg, Baden, Germany, *April 29th*, 1898.

Electric Car Accident.—It is stated that on Whit Monday one of the electric cars at the Alexandra Palace was running down an incline loaded with passengers, when the brake refused to act. The car ran down the track at great speed and collided with another, doing considerable injury. Two men who jumped from the car, also a boy, were injured.

Forthcoming Lectures.—A course of lectures on "Dynamo and Transformer Construction" will be given at the Electrical Standardising, Testing, and Training Institution, Charing Cross Road, by Mr. James Swinburne, M.I.E E., commencing Tuesday, June 7th.

Appointment Vacant.—The Aberdeen Town Council is inviting applications for the post of electrical engineer at £225 per annum. Applications have to be lodged with the Town Clerk by June 17th. See our "Official Notices."

NEW COMPANIES REGISTERED.

New & Byrd, Limited (57,453).—Registered May 23rd, with capital £5,000 in £1 shares (3,000 6 per cent. cumulative preference), to acquire the business carried on by A. New and R. New at 24, St. Thomas Street, Liverpool, as "Archer New & Co.," and to carry on the business of electrical and general engineers, electricians, and manufacturers of and dealers in electricity, motive power, and electrical apparatus. The subscribers (with one share each) are:—R. New, The Grove, Oxton, Cheshire, gentleman; A. New, Neston, Cheshire, merchant; P. H. Byrd, 36, The Woodlands, Birkenhead, electrical engineer; H. Gaskell, jun., Clayton Lodge, Aigburth; R. Edwards, 10, Ball's Road, Birkenhead, grocer; W. Buckaman, 44, Trinity Road, Bootle, miller; A. W. Willmar, 24, Village Road, Birkenhead, cotton broker. The number of directors is not to be less than two nor more than five; the first are R. New and P. H. Byrd; qualification, 50 shares. Registered by F. Wright, Palace Chambers, Westminster.

Paterson, Bell & Co., Limited (3,879).—Registered in Edinburgh, May 20th, with capital £5,000 in £1 shares, to establish and carry on in the United Kingdom or elsewhere the business of

mechanical, steam and electrical engineers, contractors, and agents. The subscribers (with one share each) are:—R. Paterson, 28, Renfield Street, Glasgow, chartered accountant; J. Spence, 28, Renfield Street, Glasgow, accountant; S. Bell, 65, Bath Street, Glasgow, engineer; J. Service, 58, Renfield Street, Glasgow, solicitor; J. B. Service, 58, Renfield Street, Glasgow, stockbroker; H. Frew, Burngreen Kilsgth, Glasgow, cashier; G. Wilson, Springfield, Helensburgh, clerk. The first directors are: R. Paterson, M. Paterson, S. Bell, and T. Carlile, 23, West Nile Street, Glasgow. Qualification, 100 shares. Registered by Oswald & Son, Edinburgh.

Dargue Acetylene Gas and Electrical Company, Limited (57,489).—Registered May 24th, with capital £5,000 in £1 shares (3,000 £5 per cent. cumulative preference), to adopt a certain agreement and to carry on the business of patentees and manufacturers of acetylene gas apparatus, electricians, mechanical engineers, and suppliers of acetylene and other gas and electricity. The subscribers (with one share each) are:—W. H. Dargue, 72, Grey Street, Newcastle, electrical engineer; F. K. Hurman, 2, St. Nicholas Buildings, Newcastle, director; C. Percy, Alnwick, solicitor; T. C. Martin, 42, Grainger Street, Newcastle, chartered accountant; W. Percy, Belvedere, Alnwick, silk mercer; A. Blake, Alnwick, solicitor; W. Armstrong, 55A, Malvern Street, Newcastle, clerk. Table "A" mainly applies. Registered by Turner & Co., 61, Carey Street, W.C.

Hydro-Incandescent Gas Light Company, Limited (57,493).—Registered May 24th, with capital £200,000 in £1 shares, to adopt an agreement with M. J. Wells & S. B. Beckles to acquire certain patent rights for Great Britain, Canada, South Africa, India and Australasia, for gas compressing and pressure regulating apparatus, and to carry on the business of suppliers of gas and electricity, gas apparatus manufacturers, electricians, electrical and gas engineers, &c. The subscribers (with one share each) are:—P. C. Beachcroft, 1 and 2, Great Winchester Street, E.C., director; M. S. Myers, 18, Finch Lane, E.C, stockbroker; S. Samuel, Stock Exchange, E.C., gentleman; S. H. Banister, 50, Wrotham Road, Camden Town, clerk; H. Howitt, 11, Victoria Street, S.W., clerk; F. J. Moore, 29, The Avenue, Ealing Dean, clerk; H. Janes, Campsbourne School, Hornsey, writer. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Qualification, £250; remuneration, £200 each per annum. Registered by Faithfull & Owen, 11, Victoria Street, S.W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

City of London Electric Lighting Company, Limited (34,406).—This company's return was filed on May 16th, when 60,000 ordinary and 40,000 preference shares were taken up out of a capital of £1,200,000 in £10 shares. £10 per share has been called on 50,000 ordinary and 40,000 preference, and £2 per share on 10,000 ordinary, resulting in the receipt of £920,000.

Corlett Electrical Engineering Company, Limited (36,200).—This company's annual return was filed on May 16th, when 620 shares were taken up out of a capital of £6,200 in £10 shares; 100 have been issued as paid, and £5,200 has been received on the others.

City of Mexico Electric Power Syndicate, Limited (55,438).—This company's statutory return was filed on May 12th, when 40 shares were taken up out of a capital of £5,000 in £50 shares; £25 per share has been called, and £880 paid, leaving £120 in arrears.

CITY NOTES.

The Brazilian Submarine Telegraph Company, Limited.

The report of the directors for the half-year ended December 31st, 1897, to be submitted to the forty-ninth ordinary general meeting, June 8th, 1898, states that the revenue for this period amounted to £100,300 4s. 3d., and the working expenses to £26,166 8s. 3d. After providing £3,200 for debenture interest and sinking fund, and £1,353 2s. 8d. for income-tax, there remains a balance of £69,580 13s. 4d.; to this is added the sum of £7,221 5s. 5d. brought forward from June 30th last, making a total of £76,801 18s. 9d. In commemoration of Her Majesty's Jubilee, and of the 25th anniversary of the foundation of the company, a bonus has been granted to the staff, amounting to £4,139 14s. 7d. First and second interim dividends, amounting to £39,000, have been paid, and £25,000 transferred to the reserve fund, leaving the sum of £8,662 4s. 2d. to be carried to the next account. The directors with great regret report the death of their esteemed colleague, Lord Sackville A. Cecil. The vacancy has been filled by the appointment of Sir John Wolfe Barry, K.C.B. Negotiations for closer working with the Western and Brazilian Telegraph Company, Limited, have been in progress, and an agreement will shortly be submitted to the shareholders.

South Staffordshire Tramways Company.

Mr. Somers L. Schuster (chairman) presided over the eighth ordinary general annual meeting of the above company held yesterday (Thursday) at the Cannon Street Hotel, and in moving the adoption of the report, said it was the first time he had been able to recommend a dividend of any sort, and he trusted they would now go from bad to better. The dividend to be proposed was 2¾ per cent. on the preference shares. The working expenses amounted to £18,247 12s. 7d. as against £17,934 in the previous year. The general expenses were £1,917 against £3,521, the decrease being due to the absence of litigation. Repairs had cost £8,000, as against £6,895. He could hold out no hope of the expenses under that head decreasing, because the permanent way must be kept up. The total receipts were £32,916 4s. 5d., as against £31,830, but he could hold out little hope of this being much further increased. He thought, with their present method of traction, they had pretty well reached their maximum. The improvement which would take place if they had a much quicker and more regular, and he might say a better method of traction, would undoubtedly tend to increase the receipts very largely. If they had a 10 minutes' service as against a half-hourly service, it would make a great deal of difference; but that was a question for the future. There was a difference of opinion on the board. Mr. Dawson held the opinion that the one thing which would help the South Staffordshire Tramways was the system of auto-traction. That had been tried for two years under the supervision of Mr. Dawson, and the report of the manager showed that it was a ghastly failure. At a recent conference held at Birmingham, all represented, with one exception, were in favour of electric traction, whether overhead or underground.

Mr. Blundstone seconded the motion.

Mr. Roff asked if anything had been done with reference to handing over the company to the British Electric Traction Company, Limited.

The Chairman: The whole thing has been completed.

Mr. Roff said he protested against the way in which the vote was taken at the last meeting.

The Chairman said had it not been for the agreement the company would have been wound up. It was neck or nothing, and they had got neck and something.

Mr. Fuller said the money might have been raised somewhere else, and it was Mr. Dawson who was the true friend of the company.

The Chairman said he went to five of the largest financial houses to get the money required, and not one would touch it.

The report was adopted.

Great Horseless Carriage Company (in liquidation).—The liquidator of the above company is prepared to receive offers for certain shares in the Motor Manufacturing Company, Limited, and shares and debentures in the British Motor Company, Limited, not taken up by the shareholders of the Great Horseless Carriage Company.

Shannon Electric Power Syndicate.—We understand that Mr. J. F'G. Bannatyne, D. L., has resigned his seat on the directorate of the Shannon Electric Power Syndicate.

The Spiral Globe, Limited.—Letters of allotment for shares in this company were posted last week.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending May 27th, 1898, were £2,653 5s. 4d.; corresponding period, 1897, £2,473 2s. 6d.; increase, £180 2s. 10d.

The City and South London Railway Company.—The receipts for the week ending May 29th, 1898, were £1,012; week ending May 30th, 1897, £929; increase, £83; total receipts for half-year, 1898, £22,678; corresponding period, 1897, £22,390; increase, £288.

The Dover Corporation Electric Tramways.—The receipts for the week ending May 28th, 1898, were £147 1s. 2d.; total receipts to May 28th, 1898, £2,357 0s. 3d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, May 27th, 1898, were £577 2s. 1d.; corresponding week last year, £561 15s. 10d.; decrease, £104 13s. 9d.; passengers carried, 89,005; corresponding week last year, 98,010; aggregate to date, £9,498 8s. 2d; aggregate to date last year, £10,049 11s. 7d.; decrease to date, £551 8s. 5d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending May 29th, 1898, amounted to £1,412; corresponding week last year, £1,310; increase, £102.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending May 27th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £3,077.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, May 25th.	Closing Quotation, June 1st.	Business done during week ended June 1st, 1898. Highest.	Lowest.
137,400*l*	African Direct Telegraph, 4 % Deb.	100	4 %	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960*l*	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	64 — 67	64 — 67	65⅛	...
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	114 —115	115 —116	115⅝	114
3,038,020*l*	Do. do. Deferred...	Stock	...	...	...	15¼— 15¾	15⅝— 16¼	15⅝	15⅛
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15¼— 15¾	15½— 16	15⅝	15½
75,000*l*	Do. do. 5 % Debs. 2nd series, 1906 ...	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	2¾— 3¼	2⅞	2¾
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	170 —185	180 —190	...	...
918,297*l*	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	105½	...
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½ %	2 %	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	6½— 7½	6½— 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14½— 15½	14½— 15½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	4½ %	103 —106%	103 —106%	...	...
60,710*l*	Direct United States Cable	20	2½ %	2½ %	...	10¼— 10¾	10⅛— 11	10 1/16	...
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	100—103	...	...
400,000	Eastern Telegraph, Nos. 1 to 400,000	10	6½ %	6½ %	...	16¾— 17¼	17 — 17½	17¼	17
70,000	Do. 6 % Cum. Pref.	10	6	6	...	17½— 18½	18 — 19	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	100 —103	101 —104	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	123 —127	124 —128	124½	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	17½— 18	17½— 18	17¾	17½
25,200*l*	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	100 —104	100 —104	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	126 —129	126 —129	...	...
35,100*l*	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	...	...
46,000*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
300,000*l*	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	101 —104	101 —104	...	...
200,000*l*	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	105 —108%	105 —108	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	4½ %	11½— 12	11½— 11¾	11⅝	11⅜
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16¾— 17¼	16⅞— 17	17¼	16 15/16
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	10 %	28½— 29½	28½— 29½	29⅛	...
160,000*l*	Do. do. do. do. 5 % Debs. ...	100	5 %	5 %	5 %	100 —103	100 —103	...	...
97,000	Halifax and Bermuda Cable, 4½ % 1st. Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	97 —102	98 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	50 — 53	50 — 53	...	...
100,000*l*	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	6 %	107 —110	108 —111	109½	...
28,000	Montevideo Telephone, 6 % Pref., Nos. 1 to 28,000 ...	5	4 %	4 %	4 %	2¼— 2¾	2¼— 2¾	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	5½ %	6 %	5½— 5¾	5½— 5¾	5 11/16	5½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 5⅝	5 1/16	5½
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	99 —104	101—106	103½	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000*l*	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	5 %	8 — 9	8 — 9 xd	8	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 —141	...	...
58,000	United River Plate Telephone	5	4 %	5 %	...	4 — 4½	4 — 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	104 —107	104 —107	...	...
15,609	West African Telegraph, 7,501 to 23,109	10	4 %	*nil*	*nil*	3½— 4½	3½— 4½	...	...
213,400*l*	Do. do. 5 % Debs.	100	5 %	5 %	5 %	99 —102	99 —102	...	...
64,289	Western and Brazilian Telegraph	15	3 %	2 %	3½ %	11½— 12	12 — 12½	11⅝	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	7½— 8	7½— 8	7 1/16	7¾
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	½ %	4 — 4½	4 — 4½	4 1/16	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph	10	⅞ %	1 %	⅞ %	½— ¾	½— ¾	⅞	9/16
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	6 %	7¼— 7¾	7¼— 7¾	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	6 %	5 — 7	5 — 7	...	...
80,000*l*	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	105 —108	106 —109	...	...
1,163,000$	Western Union of U.S. Telegraph, 7 % 1st Mort. Bonds	$1000	7 %	7 %	7 %	103 —108	103 —108	...	...
160,100*l*	Do. do. do. 6 % Ster. Bonds ...	100	6 %	6 %	6 %	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	12 — 13	12 — 13	12¾	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ord., Nos. 1 to 10,277... ...	5	5 %	5 %	6 %	8½— 9½	8½— 9½	9	...
60,000	Do. do. do. 4½ % Deb. Stock Red....	Stock	4½ %	4½ %	4½ %	115 —117	115 —117	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000 ...	10	5 %	7 %	10 %	24½— 25½	24½— 25½	25⅛	24 7/8
10,000	Do. Prov. Certs. Nos. 90,001 to 100,000 £5 ...	10	...	...	...	16½— 17½	16½— 17½	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½— 17½	16½	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 — 134	129 —134	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	*nil*	*nil*	*nil*	13 — 14	13 — 14	...	...
10,000	Do. do. do. Nos. 30,001 to 40,000 £4 paid.	10	...	...	...	6½— 7½	6½— 7½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	15 — 16	15 — 16	...	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400 £4 paid	5	...	...	...	3½— 4½	3½— 4½	...	...
10,000	House-to-House Electric Light Supply, Ord., 101 to 10,100	5	...	...	4 %	9 — 10	9 — 10	...	...
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	11 — 12	11 — 12	...	...
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	16½— 17½	16 — 17	16¾	16½
220,000*l*	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	4½ %	117 —121	117 —121	...	...
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	18½— 19½	18½— 19½	...	...
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7¼ %	10½ %	14½ %	16 — 17	16 — 17	16¾	16⅝
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. Stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2 — 2½	2 — 2½	2 1/16	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	15½— 16½	16 — 17	16⅜	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation May 25th.	Closing Quotation June 1st.	Business done during week ended June 1st, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	15½— 16	15½— 16	15⅞	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 £4 pd. (issued at £2 10s. prem. all pd.)	10	...	...	...	7 — 8	7 — 8	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½%	*nil*	*nil*	1¾— 2	1¾— 2	2	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2¼— 2½	2¼— 2½	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	101 —104	101 —104	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10⅜	10¼
129,179	Do. do. do. £6 paid	10	...	...	...	6 — 6½	6 — 6½	6⅜	...
59,254	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1¼— 1¾	1¼— 1¾	...	...
67,680	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼— 4¾	4¼— 4¾	...	...
630,000*l*	City and South London Railway	Stock	1 1/16 %	1 1/16 %	1⅛%	67 — 70	68 — 71	69⅞	69
28,180	Crompton & Co., 7 % Cum. Pref. Shares, 1 to 28,180 ...	5	*nil*	...	...	2 — 2½	2 — 2½	...	...
99,261	Edison & Swan United Elec. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼— 2¾	2¼— 2¾	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. 4 % Deb. Stock Red. ...	100	...	...	...	103 —105	103 —105	...	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	...	2⅝— 2⅞	2⅝— 2⅞	2¾	2⅝
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅜— 3⅝	3⅜— 3⅝	...	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅛— ¾	⅛— ¾	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	⅜— ⅝	⅜— ⅝	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	12 %	10 %	21½— 22½	21½— 22½	22¼	...
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	18⅓	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	4½%	110 —115	110 —115	114⅝	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21 — 22	21 — 22	21⅜	21¼
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅝%	2⅝%	3⅛%	10⅝— 10¾	10⅝— 10¾	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾— 16¼	15¾— 16¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	34 — 37	34 — 37	36½	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	133 —136	132 —135	134	133¼

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10½.

House-to-House, 4½% Debentures of £100, 107—110.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 15—16; 1st Preference Cumulative 6%, £5 (fully paid), 8—8½. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10%.

London Electric Supply Corporation, £5 Ordinary, 3½—4.

*T. Parker, £10 (fully paid), 15½.

Yorkshire House-to-House Electricity, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (April 7th, 1898).

AUSTRALIAN NEWS.

[FROM OUR OWN CORRESPONDENT.]

Electrical work in New South Wales appears at present to be confined to Government works, the trams being monopolised by the Railway Commissioners, and the only electric lighting contracts settled lately being for the lighting of various Government offices. The George Street electric tramway is beginning to show signs of progress, as work has been commenced on the permanent way at the Harris Street end of the line, and walls are springing up on the spot selected for the power house and car house, which, by the irony of fate, are on the site of the old omnibus stables. In connection with this line further contracts have been awarded to Messrs. Phippard Bros. for erecting the chimney stack for the power house, at a cost of £2,365, and to Messrs. Stewart & Co. for the erection of car house at £12,490. In the case of the former, two sets of tenders were called. On the first specification the prices varied from £5,285 to £6,864, nine tenders being received, on the amended specification ten tenders were sent in varying from £2,365 to £3,750. The car house will be 273 feet by 130 feet, built on hardwood piles, with planking, wailing, &c., with concrete foundation. There will be a suite of offices comprising employers', dining, lavatory, and store rooms; the side walls are brick, with iron principals roofed with nine spans of saw-tooth form. The roof principals, of which there are over 100 of 30 feet span, are rolled iron, supported on rolled iron columns. Front facing roadway is supported on cast-iron columns closed in with revolving shutters; back end wall consists of timber. On floor of car house is an examining pit, 114 feet by 60 feet and 4 feet deep, cars carried over same by strong iron back railbearers, 10 × 8; also a repairing pit constructed of concrete, 173 feet by 14 feet. The chimney shaft is to be of circular form, 235 feet above ground line, with concrete footing and brick base. Mr. C. Keeling's tender of £775 for the trolley wire for this line has also been accepted.

The Rose Bay tramway is also progressing favourably, the generators have been housed at last, the underground feeders laid, and a considerable portion of the permanent way laid and bonded, and the rails of the cable train, of which this line will be an extension, are also bonded with Edison-Brown plastic bonds. Feeders have also been laid, together with those for the tramway, for an electric pumping station for the Double Bay sewerage, and it is probable that the new generators will first be utilised for this purpose, as the pumping plant bids fair to be completed well before the tramway.

The Public Works Department have recently gone in very extensively for electric lighting, amongst those completed being the Hawkesbury Agricultural College, Kenmore Asylum for the Insane, Berrima and Darlinghurst Gaols, and the Government printing office. For the lighting of the Goulburn Gaol 14 tenders were received, ranging from £2,387 to £2,669, Messrs. F. Lasseter & Co.'s tender of £2,450 being accepted for Ransomes, Sims & Jefferies engine and Siemens dynamo. For the Bathurst Gaol nine tenders, varying from £1,986 to £2,616 were received. Specifications are in hand for the electric lighting of other public buildings.

In the matter of the electric lighting of the city of Goulburn, though tenders were only received from two firms, the Council have accepted the tender of Mr. R. Thompson at £7,665, to include a Lancashire boiler, Worthington pump, and three 35-H.P. engines, the system to be three-wire at 440-volts, and mains to be placed underground in the principal thoroughfares. The tender also provides for running the plant for two years at £600 per annum, charging 4½d. per unit for private consumption.

At Tamworth the Municipal Council, after a lengthy discussion, unanimously adopted the report of the Lighting Committee recommending a comprehensive scheme for the utilisation of the surplus water-power at the service reservoir for generating electricity for both the public and private lighting of the town. It is proposed to erect a duplicate set of Pelton wheels and dynamos capable of supplying from 1,200 to 1,400 16-C.P. lamps; using overhead mains, the cost is estimated at about £4,300. Steps will now be taken to secure the passage through Parliament of a Bill empowering the Council to contract with the people for a supply of electric light, also for power to make charges and collect the same. (Needless to say, that, notwithstanding repeated ministerial promises, the N.S.W. General Electric Lighting Act is still hung up indefinitely). The Council confidently anticipate being able to reduce the Tamworth lighting rate from 5d. to 3d. if this scheme is carried out, and give private consumers current at a rate equal to about half the present cost of gas.

At Broken Hill reports on the lighting of the town have been submitted by gas and electrical experts. The prime cost of electric lighting is estimated at £12,500, with an annual maintenance charge

of £2,657 10s., while the gasworks, &c., is estimated to cost £8,750 to put down and annual cost of working £1,936 10s. Under these circumstances, and as there is already an electric supply company in Broken Hill, it is hardly probable that the Municipal Council will put down an electric light plant.

The New South Wales Department of Industry recently asked the Crown solicitor to give his opinion as whether, legally considered, electricity can be defined as "goods." The Department wished to know if a place engaged in the generation of electricity was a factory within the meaning of the Factories and Shops Act of 1896. The Crown solicitor has given the opinion that, for the purposes of this Act, the generation of electricity is the manufacture of goods.

In Victoria, the recently passed Electric Lighting Act has generally stirred up the Melbourne electric supply companies. The A. U. Alcock Electric Lighting and Power Company appeared before the Postmaster-General recently to prosecute their application for an extension of the area within which they may operate. They were opposed by the municipalities of Melbourne and Hawthorne, the other corporations interested consenting to the application. It was represented that the A. U. Alcock and Australian Electric Lighting Companies were to be amalgamated, and that the joint business was to be conducted with the aid of a large amount of British capital. The money would be forthcoming as soon as the order sought was obtained, and the united company would be in a position to cater for every possible electric want in Melbourne. A compromise between the City Council and the companies was suggested, but proved fruitless. Since then the Melbourne City Council have made a further move. The Lighting Committee have recommended that the Corporation should exercise its statutory power in buying out the electric lighting companies, and undertake the whole task of supplying the metropolis with electric light. This announcement was made by the Mayor of Melbourne to the Postmaster-General in connection with a further application from the companies. Some months ago the Corporation began to supply private customers with light at a lower rate than that charged by the companies, and it is therefore claimed that the interests of the citizens will be much better served when the business of electric lighting is wholly in the hands of the Corporation. A special meeting of the Council will be called to consider the committee's report. If it be adopted—and of that the Mayor thinks there is no doubt—the necessary steps will be at once taken to determine the sum to be paid to the companies. The Electric Light and Power Act provides that each company shall receive the value of its works, materials, land, and buildings, with 10 per cent. added. The book values of the assets of the two companies amount to nearly £150,000.

In marked contrast to this, the Sydney Municipal Council are not making the slightest attempt to avail themselves of the powers granted to them by Act of Parliament so long ago. In the meantime, a number of small central supply stations are starting up, and supply mains are to be seen stretching in all directions over the house-tops; and by the time the Sydney Council do make up their minds, these will have to be dealt with as the Melbourne Corporation are now doing.

In Brisbane the Municipal Council have given notice of their intention to apply for an order-in-council under the new Act, to supply electricity within the city. Within two years from the date of the order, it is intended to construct electric lines and works in 29 streets. The Brisbane Railway Commissioners are endeavouring to arrange with the tramway company for the lighting of the long railway tunnels with electricity. The company's manager has placed the matter before the directorate to complete arrangements. The tramway company has some 24 miles of track now working.

Sydney, *April 14th*, 1898.

INSTITUTION OF CIVIL ENGINEERS' CONVERSAZIONE.

On Thursday and Friday evenings of last week the Institution of Civil Engineers' conversazione was held at Great George Street. The Civil's conversazione always possesses considerable interest for electrical men, but the 1898 gathering may be safely said to eclipse all others in this respect, the president for the year being Mr. W. H. Preece, C.B., F.R.S., whose position as engineer-in-chief to the General Post Office, and whose popularity among electrical men will, we hope, make the session, to a large extent, an electrical one. We take this opportunity of again congratulating Mr. Preece upon being appointed first electrical president of this time-honoured Institution.

On Thursday night the president, Miss Preece, and the Council, received the guests. As already intimated in our columns, there was brought together by Mr. Killingworth Hedges, in honour of Mr. Preece's election, an exhibition of electrical apparatus of historical interest.

The programme was a very elaborate one, and we quote a few of the items. The string band of the Royal Engineers played in the Hall during the evening; there were exhibitions of views by the biograph; an exhibition by Captain Abney of Dr. Joly's process of photography in natural colours; a demonstration by Mr. Campbell Swinton on some phenomena of the electric discharge in vacuo; a demonstration of wireless telegraphy by Mr. J. Gavey; and various engineering models and scientific apparatus were on exhibition. Mr. Wallis-Jones, of the Electric Welding Company, showed the latest type of automatic electric welder, and samples of recent advances in electric welding; Hon. C. A. Parsons had on view a unipolar dynamo made in 1887, and an 1884 turbo-generator. The Edison & Swan Company's exhibit comprised some of the earliest Ediswan lamps and holders, including the original Swan lamp lent by Mr. Swan. Mr. Crompton showed a Crompton-Pochin projector arc lamp, a 1,000-ampere automatic zero cut-out, a 500-ampere heavy pattern switch, and electric thermometers at work. Mr. James White had a number of Kelvin instruments; Mr. Cowper-Coles had parabolic reflectors; Dick, Kerr & Co., sections of rails and sleepers; Mr. L. B. Atkinson, early types of Swan & Lane-Fox lamps. Mr. Alexander Siemens exhibited an electric drill, a deck driller, a Hughes telegraph transmitter, a Cardew transmitter, a submarine detector and exploders. Mr. Killingworth Hedges, in addition to his collection of apparatus, showed specimens of copper rapidly deposited by electrical currents of high densities. Mr. W. E. Gray (Silvertown) had some cables and electric light apparatus on view, and Messrs. Barnard & Carver showed arc lamps applicable to photo-micrography and other projection apparatus. Messrs. A. Wright & Co. exhibited a 60-inch Letheby-Bunsen standard photometer made by them for the Hinckley Urban Council. Mr. Preece lent a Gaulard and Gibbs transformer. Mr. Lundberg showed a number of his specialities. Edmundson's Electricity Corporation showed some original types of electrical fittings. Mr. Hedges lent a Gramme dynamo made by Mr. W. Blanch Brain about 1878, the original Lane-Fox meter, and system of cut-outs, fuses, and switches invented by Lord Kelvin about 1881. Mr. A. G. Lyster showed some early Serrin lamps.

From the above notes may be gained a general idea of the very varied and interesting character of the exhibition which formed an important feature in the conversazione arrangements.

SOME NOTES ON AN ELECTROLYTIC METHOD FOR THE RECOVERY OF GOLD FROM CYANIDE SOLUTIONS.*

By SHERARD COWPER-COLES, A.M.I.C.E., M.I.E.E.

One of the chief difficulties appertaining to the economical recovery of gold from weak cyanide solutions by electrolysis has been the electrodes. If several sheets are cut superimposed, the strips cling together, and have to be carefully spread out one by one, so that the surface may be exposed to the solution. A clean up is made every seven or eight weeks, when the wood frames carrying the lead strips are withdrawn, the lead strips removed, and new substituted, the auriferous lead being ultimately melted down and conveyed to a central works to be cupelled. This method is both crude and expensive, the labour of fitting the strips into the frames is considerable, and the consumption of lead is a considerable item, having been computed by Mr. Von Gernet, at the Worcester mine, at 1·10 of a penny per ton of ore treated, and Mr. Williams, at the Crown Reef Gold Mining Company, at 1·75.

The cathode should fulfil the following conditions:—

1. The gold must be adherent during the process of deposition.
2. The gold must be capable of being readily stripped after removal from the electrolysing cell.
3. The cathode should be electro-positive to the gold in solution, so that it is coated with gold on immersion.

These conditions are fulfilled, I find, by substituting an aluminium cathode for a lead one, advantage being taken of the fact that a loose film of oxide is very rapidly formed on aluminium, the difficulty in soldering and electro-plating aluminium for this reason being well known. The substitution of aluminium for lead foil, or strip, enables the gold to be obtained as pure gold, and daily returns to be made of the amount of gold recovered; it also has the additional advantage of reducing the cost of labour and economising the amount of cyanide of potassium used, as the solution is not contaminated by any base metal such as zinc. The deposition of gold from a cyanide bath on to an aluminium plate proceeds in a uniform manner, but in such a way that the gold is deposited as a metallic sheet which is easily detachable from the aluminium cathode. This peculiar property of aluminium is made use of in the invention so that the gold deposit can be removed by stripping or peeling or rubbing almost as soon as it is formed, and if as proposed, the aluminium cathode consists of a sheet of the metal fixed to a revolving drum or cylinder, by varying the rate of rotation the film of gold can be brushed or removed from off the cathode continuously, so that the process is an automatic one, resulting in the immediate and continuous recovery of the gold without any subsequent cupellation of the lead as in the older electrolytic process.

The process has therefore in it the elements of economic working, coupled with the quick recovery of the valuable gold. In the Siemens-Halske process, the lead cathodes remain some weeks in the bath, and the gold, which only then amounts to about one-tenth the weight of the cathode, is only recoverable therefrom after a second further operation of smelting and cupellation. In the Siemens-Halske process lead was chosen as the cathode, as it has the property of allowing the gold to adhere to it. In the aluminium process aluminium is used as the cathode, as it permits of the easy removal of the gold film. In the former process the gold has to be won from the lead by a secondary operation; in the latter the gold is directly obtained in the form of a pure foil, without any further expense or trouble. Gold, by this process, has been successfully extracted from cyanide solutions containing only ·01 per cent. of cyanide of potassium, and

* Read before the Institution of Mining and Metallurgy, April 20th, 1898.

2½ dwts. of gold to the ton of solution. The best results are obtained when the solution is raised to a temperature of about 100° F.; it is also found advantageous to use a greater current density with the necessary increased voltage when the aluminium plates have been freshly placed in the solution, so as to ensure their being covered with a film of gold as quickly as possible, otherwise there is a tendency for aluminium hydrate to be formed. In about 10 hours an extraction of 95 per cent. can be obtained by the use of the aluminium cathodes, the amount of gold in solution before electrolysis being 2½ dwts. to the ton of solution, and the strength of cyanide ·01 per cent. and the rate of flow about 15 gallons per 100 hours for every cubic foot of electrolysing cell or three square feet of cathode surface. Gold has been deposited on aluminium cathodes from solutions containing only ·0075 per cent. of cyanide of potassium; the current density per square foot being ·03, and E.M.F. at the poles of the generator 6 volts.

The following are the results obtained from gold cyanide solutions of varying strengths, with aluminium cathodes and iron anodes.

First Experiment.

A cyanide solution containing 3·2 grammes = 2 dwts. gold per gallon and 22·71 grammes per gallon of potassium cyanide or 0·5 per cent. solution was electrolysed. The aluminium cathode had an area of half a square foot, and two similar sized iron plates formed the anodes, placed 1¼ inches from each side; the amperage being 1·50 and the voltage 1·40 at the terminals of the electrolysing cell. The gold began at once to deposit on the aluminium cathode as a bright coherent coating, and the deposition was allowed to continue for 15 minutes, when the amperage was found to be 2·0 and the voltage 3·40. The layer of gold could be completely and easily detached by rubbing gently with a piece of india-rubber tubing fixed on a glass rod.

A fresh cathode was then inserted.

Time of immersion	...	1.05	...	Amps., 3·10	...	Volts, 4·40
Taken out	...	1.20	...	„ 3·20	...	„ 4·60

The gold was removed from this cathode, and a fresh one inserted, without changing the conditions.

Taken out	...	1.50	...	Amps., 2·60	..	Volts, 4·70

As gold still continued to be deposited the experiment was continued.

Time of immersion	...	2.20	...	Amps., 2·80	...	Volts, 4·70
Taken out	...	2.55	...	„ 2·60	...	„ 4·80
Time of immersion	...	3.0	...	„ 2·30	...	„ 4·60
Taken out	...	4.0	...	„ 2·20	...	„ 4·90
Time of immersion	...	4.15	...	„ 2·60	...	„ 4·90
Taken out	...	5.15	...	„ 2·00	...	„ 4·90

The whole quantity of gold recovered in these six experiments was well washed to remove traces of potassium cyanide, and then weighed—

Gold added	...	3·200 grammes	...	100 per cent.
Gold found	...	2·7108 „	...	84·70 „

It will thus be seen that 84·70 per cent. of the total gold was recovered from the solution in 3 hours 35 minutes, using an average amperage of 2·51 per plate, or a current density of 5·02 amperes, and an average voltage of 4·63.

Second Experiment.

In this experiment a weaker solution of potassium cyanide containing 11·35 grammes per gallon = 0·25 per cent. solution was employed. The percentage of gold was nearly doubled, viz., 91 grains = 5 = 94 grammes = 3·80 dwts. per gallon.

The experiment was divided into two portions, the yield of gold at each stage being determined.

First stage:—

Time of immersion,	11.15	...	Amps., 3·00	...	Volts, 4·75
Taken out ...	...	1.05	...	„ 2·00	...	„ 5·10

Second stage:—

Time of immersion,	1.20	...	Amps., 2·10	...	Volts, 4·90
Taken out ...	...	3.40	...	„ 2·00	...	„ 4·80

The experiment had to be discontinued at this stage owing to a short-circuit taking place within the cell.

The gold recovered—

First stage, in 1 hour 50 min., 3·005 grammes = 50·59 per cent.
Second stage, in 1 hour 20 min., 0·875 grammes = 14·73 per cent.

A total quantity of gold amounting to 65·32 per cent. was, therefore, recovered in 4 hours and 10 minutes, although it will be noted that the greater part of the gold was deposited in the first two hours.

Third Experiment.

A solution containing 6 dwts. of gold per gallon and 32·71 grammes of potassium cyanide, being a 0·5 per cent. solution, was employed.

The gold was deposited in three stages and weighed separately, as follows:—

First stage—

Time	...	5.30	...	Amps., 6·25	...	Volts, 4·30
Taken out	...	6.00	...	„ 5·20	...	„ 4·10

Gold deposited, 2·930 grammes = 32·02 per cent.

Second stage:—

Time	...	6.12	...	Amps., 4·80	...	Volts, 4·10
Taken out	...	6.45	...	„ 4·20	...	„ 4·30

Gold deposited, 1·340 grammes = 14·68 per cent.

Third stage:—

Time	...	6.55	...	Amps., 2·20	...	Volts, 2.30
Taken out	...	8.45	...	„ 2·10	...	„ 2·30

Gold deposited, 2·055 grammes = 22·46 per cent.

69·13 per cent. of gold was thus recovered in 3 hours 33 minutes, and the greater part was also deposited in the first half hour, viz., 32·02 per cent.

These experiments demonstrate that the process affords a quick method for depositing gold from its cyanide solutions, and also show that it is easy to remove the film of metallic gold from the aluminium cathode by mechanical means.

In another experiment some gold tailings were carefully assayed, and found to yield a button of gold, equivalent to 1·4 grammes gold per 1,000 kilos., or approximately 1 dwt. per ton.

The quantity of tailings used for testing the efficiency of the process was 90 lbs. This quantity was placed in a suitable vat, and treated by the well-known methods for extracting the gold by means of a cyanide solution. The tailings were first leached with a weak caustic soda solution, containing 4 ounces caustic per ton of water, and after its removal, a cyanide solution containing 0·5 per cent. K C N was added. This solution was allowed to leach the tailing for several hours, and was then drawn off into an electrolytic vat. The tailings were then leached dry for some hours in order to ensure the complete solution of the gold, and the double cyanide so formed was leached out with a weak cyanide solution containing 0·18 per cent. K C N. After this solution had been drawn off into the electrolytic tank the last traces of the gold solution was washed into the vat with water. The time occupied for the whole operation was 50 hours, so that it represented the same time as is used in actual practice on a commercial scale. The total amount of liquors obtained in this way and submitted to electrolysis amounted to about 50 litres, or about 11 gallons, or about half the weight of the tailings treated.

From the above assay the theoretical quantity of gold which should be extracted from the above weight of tailings is 0·056 gramme, or $\frac{1}{30}$th of a dwt. On submitting the solution to electrolysis, a current of 0·29—0·31 ampere was employed, at a pressure of between 6 and 7 volts. As the area of the aluminium cathode was approximately 1 square foot, the current density corresponds to the amperes. The electrolysis was allowed to proceed for seven hours, and at the end of that time the gold was seen covering the whole of the cathode as a very bright golden deposit of extreme thinness. Notwithstanding the thinness of the film, it was found possible to detach it mechanically.

THE DIESEL OIL ENGINE.

As considerable attention has of late been directed to the Diesel motor, it may be of interest to compare its operation with other internal combustion engines from which the Diesel motor differs in one rather important principle.

In the standard, or Otto type of engine, worked either by gas or by oil, there are four strokes of the piston in the full power cycle, two out-strokes and two in-strokes in the following sequence: No. 1, an out-stroke drawing in a charge of gas and air. No. 2, an in-stroke compressing this charge, which is ignited by *external means* just at the point of maximum compression. No. 3 is the out-stroke during which the ignited gases do work on the piston, and No. 4 is the in-stroke of exhaust when the products of combustion are expelled. If a good diagram be examined from an ordinary gas engine, it will be observed that the compression line is joined to the expansion line by a vertical line of explosion. This shows that the gas mixture, compressed in the clearance space of the cylinder is burned instantaneously, or to use the physicists' terms, the combustion takes place at constant volume. The volume of the clearance space controls the pressure of compression. Apart from the heating of the charge by compression and from the cylinder walls, the pressure will simply vary with the ratio of the total cylinder volume to the clearance space. Thus if the clearance is 20 per cent. of the total volume, the compression will run up to five atmospheres. Obviously, as explosion takes place at constant volume, it must be accompanied by an increase of temperature.

By compressing a gas its temperature is raised, the work of compression becoming converted into heat. Conversely if a gas be compressed it will ignite more readily than when not compressed. By very high compression it would be found that the charge in a gas engine would explode spontaneously, and ignition might be thus secured without external means. In the oil engine of the Hornsby-Akroyd type ignition would always be premature if it were not that the vaporiser were shut off from the cylinder by the long bottle neck through which the air necessary to explosion has to travel to mix with the oil vapour in the hot vapouriser. In the Diesel motor there are two differences from the foregoing mode of working. In the first place the compression is very great, rising to over 500 lbs. per square inch. At this high compression the combined effect of compression and of the cylinder heat is to raise the temperature of the compressed charge to a very high point, so high, indeed, that if a combustible were present it would ignite. The compressed charge consists of air only, and at the point of maximum compression, fuel is introduced by means of a small pump, and as the piston moves on its outward working stroke the combustion of the injected fuel maintains the temperature so that the expansion line is much fuller than the compression line, the difference being work. By regulating the fuel admission the combustion does not cause, as in the ordinary engine, a sudden and large increase of temperature, but merely as above stated keeps up such temperature as was attained by

compression, the endeavour being to secure isothermal expansion. There is, in fact, no sudden explosion in the Diesel engine. The fuel ignites as it enters a vessel of highly compressed air and burns just as an ordinary gas jet burns when it enters the atmosphere from a common burner with a light to give its initial ignition. The large ratio of air present, its high pressure bringing every particle of fuel into close contact with plenty of air, produces a perfect combustion. Obviously with such high pressures the expansion ratio can be great, and it is said that the clearance space is not over 7 per cent. Hence in the larger sizes compound working is resorted to. The compound Diesel motor is made so far with two high pressure cylinders and one low pressure cylinder, the latter having a working stroke every revolution and taking its charge from the high pressure cylinders alternately, these being arranged to alternate their working strokes for this purpose. One end of the low pressure cylinder is used as the first stage air compressor. Air is partially compressed into a reservoir, whence it flows to each of the small cylinders, and is in them compressed to about 500 lbs. The Diesel motor differs from the ordinary gas engine in not having an explosive mixture to compress. It works simply by the heat effect of a flame burning in compressed air.

So far the fuel used in this new motor seems to be oil, but powdered coal has been suggested as a practical fuel, though it seems to us that the dust therefrom would be prejudicial in vertical engines except where the shaft is above the cylinders, so that dust cannot reach the pistons so readily, an arrangement much against the possibility of introducing the coal by gravity. Originally, too, the water jacket was not to have been employed, but has been found necessary.

It is claimed that a fuel efficiency is secured of 28 per cent. as against 18 per cent. for ordinary gas engines. Even half of this saving would mean a very big saving. The doubts that will advance themselves will be in reference to the satisfactory working of an internal combustion engine with such very high pressures. Given this item, and there is no reason why the Diesel motor should not succeed and be economical. But except that it compresses air only and injects its fuel when ignition is required there is not so very much really new about it. It has long been known that increased compression meant an increased economy in the gas engine. Increased compression could not, however, be arranged, or there would be premature explosion, and high compression is thus only possible with the new method of supplying fuel. The Diesel motor is in fact a device for securing high compression, as pointed out by theory, should be secured. The fact that the compressed charge is all air, causes the combustion of the fuel jet to be very perfect, and there is no smoke or smell from this motor.

Generally speaking, the theory seems to be all right. Can the practice be made so? This is, of course, a question for constructive mechanics. The pressure to be employed is one which must tell seriously upon pistons, though against this is to be set the absence of explosive action. The maximum pressure is brought gradually on the parts during the compressive stroke, and the pressure line of the diagram is merely kept above the line of compression by the heat action of the burning jet. Originally the inventor talked of a compression running into hundreds of atmospheres and there was to be no water-jacketting.

The engine experimented with in Germany about 1894 had a compression of 90 atmospheres. As now being made, we believe about 35 atmospheres is the maximum compression; there is a water jacket, and the efficiency, instead of the hoped for 60 to 70 per cent., is less than 30 per cent. The inventor has set himself a difficult task. We should like to see him succeed in a very praiseworthy attempt to secure motor working nearer to thermo-dynamically correct lines. As he himself said, if the very high pressures he proposed could be employed, motors would become mere models compared with our existing steam engines. In Herr Diesel's book, "The Rational Heat Motor," published about four years ago, very high expectations were held as to the possibility of high pressures and the abolition of the water jacket and efficiencies of 70 per cent. were anticipated. Could the water jacket be abolished in the ordinary gas engine, it is a question whether over 60 per cent. efficiency could not be obtained at ordinary pressures. The practical question now is, is it likely to pay to use even the low pressure of 500 lbs. for the sake of getting 28 per cent. efficiency, and is the Diesel motor offering promise of anything more than this after its few years' trial and experience?

THE ECONOMICAL USE OF EXHAUST STEAM.

Writing in the *Electrical World*, Mr. Perkins considers the question of using exhaust steam. He instances a water-power where the driven factory uses so much steam for drying purposes that the firemen cannot tell when the relay engines—used when the water is low—are running or standing, because all the engine exhaust is available for heating purposes. He very properly questions the economy of the water-power in this instance. Another instance is cited where a college is electrically lighted, and is heated also from the exhaust steam, and, owing to certain minor improvements introduced when the light was installed, the fuel bill is less than it was before there was any light. The light really costs nothing, for the heat was previously required.

It would appear, however, that in paper mills the reverse may be the case, and Dr. Louis Bell has protested against the use of exhaust steam for drying purposes, while a case is given by a Mr. Schillit where an engine 13 inches × 21 inches × 175 revolutions per minute drove the mill and heated 13 driers and used 2,868 lbs. of steam per hour with a back pressure of 23 lbs. When exhausting freely, and using live steam for drying, the consumption, all told, was only 2,745 lbs. In each case there were 14 other driers heated, in both cases by live steam The question seems to resolve itself into one of the increased steam consumption of the engine with 23 lbs. back pressure. To approximate to this, he prepares a diagram showing the percentage of extra steam in an engine 14 inches × 36 inches × 85 revolutions per minute, producing 100 H P., and he shows that it will not pay to incur 6 lbs. of back pressure for the sake of using the exhaust unless the amount of exhaust used exceeds 20 per cent. of the steam used by the engine under normal conditions. If only 3 lbs. back pressure is needed, then 10 per cent. of the normal steam must be used. These conditions assume that the remainder of the exhaust is blown away at the increased pressure. It appears that the 13 driers did not require so much steam as the engine used normally. Yet a back pressure of 23 lbs. implied that the engine must double its consumption, and obviously the consumption would be greater than if there were a free exhaust and live steam in the driers, and that if the other 14 driers had been available for exhaust heating there would have been economy. The lesson to learn is not that the use of exhaust is not an economy, but that it should be freed from conditions of back pressure, unless the whole of it is needed. Clearly it is poor practice to close up the exhaust of a big engine in order to force steam through long pipes to boil one glue kettle.

ON THE PRODUCTION OF A "DARK CROSS" IN THE FIELD OF ELECTRO-MAGNETIC RADIATION.*

By JAGADIS CHUNDER BOSE, M.A., D.Sc., Professor of Physical Science, Presidency College, Calcutta.

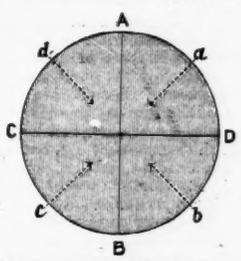
A circular piece of chilled glass when interposed between crossed nicols produces a dark cross. A similar effect is produced by crystals like salicine where there is a radial disposition of the principal planes.

I have been able to detect a similar phenomenon in the field of electric radiation by the interposition of an artificial structure between the crossed polariser and analyser.

I have in a previous communication described the polarisation produced by the leaves of a book. For the following experiment, a long strip of paper was rolled into a disc. A roll of Morse tape serves the purpose very well. The diameter of the disc is 14 cm. and its thickness 2 cm. It will be observed that here we have a single axis passing through the centre, and that all planes passing through the centre are principal planes.

The effect produced by the interposition of the structure may be studied by keeping the disc fixed and exploring the different parts of the field by means of the detector; or the detector may be kept fixed (opposite the analyser) and the disc may be moved about so that the different parts of the field may successively be brought to act on the detector. This latter plan was adopted as being simpler in practice.

The arrangement of the apparatus is the same as in fig. 1 of my



A B, C D, are the vertical and horizontal diameters.

Fig. 1.—The Paper Disc.

paper "On the Rotation of Plane of Polarisation of Electric Waves by a Twisted Structure." The polariser is vertical and the analyser horizontal. The paper disc is interposed between the screens with its plane at right angles to the direction of the ray.

The receiver is fixed on the prolongation of the line (which I shall call *the axis*), joining the centres of the polariser and the analyser.

On the supposition that the interposition of the disc produces a dark cross, the arms of the cross (with the particular arrangement of the polariser and the analyser) will lie in the projections of the vertical and the horizontal diameters of the disc, and will move in space with the movements of the disc. When the centre of the disc is on the axis, the intersection of the cross will be superposed on the receiver, and there should then be no action. If the disc be moved up and down, the centre remaining in the vertical line passing through the axis, the vertical arm of the cross will slide over the

* Communicated to the Royal Society by Lord Rayleigh, F.R.S. Received February 14th, read March 10th, 1898.

receiver. If the disc be moved laterally, with its centre in the horizontal line passing through the axis, the horizontal arm of the cross will slide over the receiver. In this, as in the last case, there should be no action on the receiver. But if the disc be displaced so that the centre does not lie in either the horizontal or the vertical line passing through the axis (the axis now cutting the disc at points such as *a*, *b*, *c*, or *d*), the arms of the cross will not fall on the receiver, and there should be a response in the receiver.

The experiments were now arranged as follows:—The disc was at first placed with its centre on the axis, the plane of the disc being perpendicular to the axis. There was now no action on the receiver; but as soon as the disc was tilted, however slightly, an action was immediately produced on the receiver.

The disc was now mounted on a stand, between the two screens. By means of sliding arrangements the disc could be raised or lowered, or moved laterally.

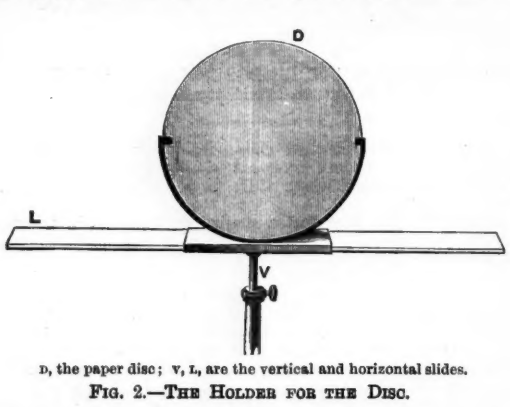
In the next experiment the centre of the disc was first adjusted on the axis, and the disc moved vertically up and down. No effect was produced when this was being done.

The centre of the axis was again adjusted on the axis, and the disc moved laterally on the horizontal slide. In this case, too, there was no action.

By adjusting the vertical sliding rod the centre of the disc was next placed vertically above or below the axis. The disc was then moved laterally either to the right or to the left. In this way the field could be displaced, and the quadrants, *a*, *b*, *c* or *d* (see fig. 1), placed opposite to the receiver. In all these cases, even with small displacements, very strong action was produced on the receiver.

From experiments carried out in the manner described above, the outline of a dark cross projected in space was distinctly made out.

A disc of wood, with *concentric rings*, would probably show the effect equally well. I shall, in a future paper, send an account of the



D, the paper disc; V, L, are the vertical and horizontal slides.

FIG. 2.—THE HOLDER FOR THE DISC.

action of crystals cut perpendicular to the axis placed in convergent or divergent beams of electric radiation.

Some of the investigations on the rotation of the plane of polarisation will, perhaps, be facilitated by an observation of the rotation of the cross. By a modification of this method I am at present trying to detect the rotation produced in a magnetic field.

ADDENDUM, MARCH 16TH, 1898.

The production of a dark cross can also be demonstrated by interposing between the crossed polariser and analyser concentric rings of tinfoil mounted on a thin sheet of mica. But greater interest is attached to the exhibition of the phenomenon by double refracting substances, where the axes of elasticity are disposed in radial directions. From the peculiar stresses present, I surmised that woody stems with concentric rings would exhibit the phenomenon above described. Through the kindness of Dr. Prain, I obtained from the Government Botanical Gardens, Sibpore, stems of *Pinus longifolia*, *Swietenia mahogani*, *Araucaria Cunninghamii*, *Mangifera indica*, *Casuarina equisetifolia*, *Cupressus torulosa* and *Dalbergia sissoo*. The ring systems present in some of these were very regular. I was, however, at first disappointed in failing to obtain the results anticipated. But this failure, I subsequently found, was due to the general opacity of the wood, which was freshly cut, and which, though apparently dry, contained large quantities of sap in the interior. I then carefully dried some of the specimens, when the stresses present became quite apparent by numerous cracks starting in radial directions. The results obtained with these dried specimens were quite satisfactory.

I now tried to devise some experiments strictly analogous to the optical experiments with chilled glass. For this purpose I cast a cylinder of paraffin wax in a metallic mould surrounded by a freezing mixture. Owing to the great contraction produced by solidification, a hollow depression was formed in the centre, and this produced a distortion of symmetry. It would, therefore, be better to build up a cylinder by successive dippings, the deposited molten layer contracting on the solid core. I obtained, however, extremely good results with a cylinder of cast ebonite, in which the stresses present are exactly similar to those in a circular piece of unannealed glass.

The next series of experiments were undertaken with mineral specimens. I here acknowledge with thanks the kind help I received from Mr. Hayden, B.A., and Mr. Blyth, of the Geological Department, in obtaining suitable specimens for my experiments. One very interesting specimen obtained from Egypt was formed by ringed concretion of flint round a central nodule. This specimen exhibited the cross with great distinctness. I also obtained fairly satisfactory results with stalactite. The concretion of calcium carbonate formed inside a pipe by deposits from temporarily hard water flowing through it, would also be found to exhibit this phenomenon.

NEW INDUCTION COIL.

Abstract of a paper read before the Röntgen Society by ALFRED APPS, *M.I.E.E., and Member of the Röntgen Society, on May 10th, 1898, entitled "Notes on the Description of a 'New' Induction Coil, 'Electrical Review,' February 4th, 1898, page 165."*

THE author considers many of the points advanced to be erroneous, and he insists that the members of the Röntgen Society require the most accurate information with a view to the improvement of their X ray appliances. Dealing with the statement that the Ruhmkorff coil is the only one in use, he adduces facts showing that it was, for all practical purposes, superseded some 28 years ago. Ladd greatly improved it, and the author devised a new form both as to coil and accessories which became, with further details, the subjects of a series of patents. These instruments are now known as Apps coils. On the subject of efficiency, it is pointed out that the Ruhmkorff coil, an excellent instrument 30 years ago, weighing about 20 lbs., and giving 1½ inches spark of about the same dimensions as the Apps coil of the present day, giving 8 inches spark. This coil has about 6½ miles of wire as secondary as against the 8½ miles which, by calculation, appears to be coiled on the central bobbin of the "new" coil described in the ELECTRICAL REVIEW. The weight there stated, 660 grammes, appearing to be a misprint. It is contended that experience is the best answer as to decay or burning of insulation in the secondary coil, and particulars are given of many coils of the Apps manufacture under the patents referred to, where no decay could be found after nearly 30 years' use, nor diminution of spark length. Cases of extreme damp, immersion in sea water, &c., acid fumes, and direct sunlight impinging on the ebonite exterior are excluded. High power and portability, as in the 8 to 10-inch Apps coils are urged as important for X ray work. The dimensions of secondary bobbins are discussed, and by means of a diagram it was shown that the sectional area of the secondary bobbin of a nominal 4-inch Apps coil working to 7 inches, was practically the same as that of the "new" coil. In answer to the assertion that all coils are defectively insulated, experience is again advanced. The author, however, admits the extreme desirability of high insulation, but points out that other qualities have to be sought, such as portability, strength, freedom from chemical action leading to explosion and ignition. As an example of high efficiency, where a spark of 4½ inches was reached (as long as the bobbin), the coil made by Apps for the late Mr. W. Spottiswoode, F.R.S., is mentioned (see *Phil. Mag.*, Jan., 1877, p. 30). Fluid insulators are discussed at some length; and replying to the proposals in the ELECTRICAL REVIEW, the author declines to grant that, all things taken into account, any advantage can be gained by the use of fluid insulators for the secondary of an induction coil. In supporting this view, he refers to the very limited use of oil for the insulation of transformers where the voltage is exceedingly low in comparison with that employed in the induction coil. To show the danger of an accumulation of carbon formed from the oil, he instances the case of a condenser, 20,000 volts only, where there was found to be an accumulation of carbon in the glass cell. In this case resin oil was used. It is further pointed out that authorities differ widely as to the insulating power of oils—that the nature of the electrical discharges affect the percentage or efficiency of oil insulators to an extreme degree, and, further, that the precise nature of the electrical excitation in the secondary of a coil is not satisfactorily known, and that, therefore, the value of oil insulation is uncertain. As there is carbon formed in all oil insulators—certainly when the electrical stress is great. It is produced in the interstices of the secondary winding, thereby destroying all insulation and cannot fall away by gravitation. In 1870 the author, in conjunction with Mr. H. C. Baines, of Pembroke College, Oxford, tested the use of oil in induction coils, and discarded it for similar reasons.

The danger of accumulations of gas in oil insulated coils is discussed at considerable length. The visible bubbles rising to the surface while the coil is working and the possibility of enlarged bubbles being formed in the interior parts and then fired by a minute spark, lead the author to conclude that considerable danger of an explosion is incurred. He has seen such explosions, and refers to Tesla's description of a coil tried when unfinished in a darkened room presenting the appearance of a "mass of fire." The author some 20 years ago was endeavouring to ascertain how small a spark would explode gas. He employed a common medical magneto machine, with a small condenser attached to the rotating contact breaker. Sparks scarcely visible of about $\frac{1}{10}$th inch long thus produced were found sufficient to fire a mixture of coal gas and air

Much has been written as to the proper shape of the secondary coil, and as a contribution to the history of this matter, and to show that the bobbin recommended in the ELECTRICAL REVIEW is not the best, reference is made to the experiments of Mr. Ladd about the year 1860. He thoroughly tested the use of various forms, and found no advantage from a large central bobbin. It is contended that the lines of force, within which the secondary wire must be placed, are found in such positions and relative intensities (Kapp lines per square centimetre) that one is led, both by theory and experience, to wind the wire nearly to the whole length of the primary coil, and in depth

equal to about one-eighth of the length. The wire recommended, 0·16 cm., is considered too small for a coil designed for 20 cm., or about 8-inch spark.

The author thinks that no good can be gained by undue economy as to secondary wire, and he refers to the use of iron wire now largely employed in very cheap coils which soon rusts asunder, and he humorously says that there are also other devices for constructing coils so as to make them last for a short time. With special reference to X ray work, it is pointed out that unless the secondary coil be of considerable length, the sparks will not be so frequent as to give good results. It is an outpouring of energy that is required, and not a simple disruptive discharge. The great coil made for Mr. Spottiswoode gave a continuous outflow at each discharge for at least half a second when the terminals were separated from 1 to 2 inches, and it is precisely this effect, though necessarily less in degree, that is wanted for the best X ray work.* As an instance of long spark lengths from a small quantity of wire a 3-inch Apps coil is referred to, which, as a maximum, gave 6½ inches. In conclusion, it is stated that induction coils can now be constructed according to specified conditions—it is simply a matter of ordinary electrical engineering practice found to follow very closely the data the author has accumulated during an experience of 33 years. Finally, he expresses his thanks to the authors of the paper in the ELECTRICAL REVIEW.

NOTE ON MR. APPS'S PAPER ON "A NEW INDUCTION COIL."

Mr. Apps's long experience in the manufacture of induction coils with a deservedly high reputation entitles his opinions to the greatest respect. In some respects, however, we think his criticism of the coil invented by MM. Rochefort-Lucay and Wydts (ELECTRICAL REVIEW, 42, p. 165) is unfair. He objects to the statement at the commencement of that article that the Ruhmkorff coil is the only one in general use, but Mr. Apps must know that the term Ruhmkorff coil is in general use for the modern induction coil, and does not mean the coil exactly as it was constructed more than 40 years ago by Ruhmkorff. The first Ruhmkorff coil imported into this country by Groves in 1852 had 10,000 turns in the secondary coil, and gave only a ½-inch spark in air. But since that time many important improvements have been made in its construction, by which Mr. Apps, as well as other makers, have been enabled to leave far behind the original inventor of the induction coil; for instance, Sinsteden applied the condenser in 1855, Ritchie invented winding the secondary in compartments in 1857, and many improvements were made in the contact breaker by other inventors. Liquid insulators even, were tried with success by Jean in 1858. Mr. Apps makes excellent coils, and no doubt has discovered many important improvements in details in the course of his practice. We quite agree with him that the central coil shown in the illustration of MM. Rochefort-Lucay and Wydts's coil is not the best disposition of the secondary wire. But as we understand it that is not an essential part of their invention, Mr. Apps's remarks on liquid insulators appear also to be beside the question. The French inventors' improvement consisted in the use of *viscous or pasty* insulators, which in many respects have different properties from liquid insulators—for instance, they can stand a longer static strain without allowing the electricity to leak away by convection. The excellent results obtained with the viscous insulators, even though they might not have appeared quite so good if an Apps coil had been used for comparison, indicate that it may be worth while to make further experiments in this direction. Mr. Apps alludes to a series of patents in which his improvements in induction coils have been embodied; we can find only two, one in 1867, and one in 1896. The first patent relates principally to his well-known and excellent contact breaker, and the second principally to matters of detail in the insulation of the primary and secondary coils. In these patents there appear to be no epoch-making steps in the evolution of the induction coil, or at least nothing to justify Mr. Apps in drawing such a hard and fast line between the Apps coil and the Ruhmkorff coil. We readily acknowledge that Mr. Apps makes excellent coils, but all the same, we do not think he has yet reached the *ne plus ultra*. The present low efficiency of the induction coil as a transformer of electric energy leaves plenty of room for improvement.—EDS. ELEC. REV.

BELT DRIVING.

I.

EVERY species of power transmitting device has its advocates. These advocates often push the virtues of their pet ideas in and out of season and irrespective of surroundings. We can hardly say this of Mr. Tullis who, in his paper on "Belt Driving," read before the West of Scotland Technical College Scientific Society, certainly said all he could for belts, but did not seriously overstate matters. He certainly gave some very useful points to his hearers. For really high class belting the centre of a belt ought to be the centre of the hide, the spine of the ox lying evenly between the two halves of the strip. Such belts should be cemented and stretched, and properly made, will run perfectly true and straight. A safe tension is 50 lbs. per inch of breadth of $\frac{1}{16}$ single leather, and 80 lbs. for double leather. On this item of cementing, the present writer was recently asked to supply a length of the best 4-inch belt to be obtained. He sent the "all cemented joints" of a leading maker, and the engineer rejected the belt as not the best. It is thus clear that belt users are in need of instruction. It is often most difficult when supplying the very best goods in the market to obtain credence for the fact. In regard to the care of belts there should be no dust allowed to cake on a belt, and a belt face should be clammy and should be kept from undue dryness by a reliable dressing. We can understand this, but what is a reliable dressing? A pulley ought not to become bright, this implies slip. A non-slipping belt makes a pulley face dark coloured.

A belt only slips if out of condition or overloaded. Slip implies friction and loss of power and destroys a belt. If overloaded a belt can be compounded. Mr. Tullis is great on compounding. A compound belt is simply one belt running freely on the top of another. An 8-inch belt run on a 12-inch belt is equivalent to a 20-inch belt, the 8-inch belt will do as much work as if on a pulley of its own. When running at over 4,000 feet per minute belts ought to be thin, pliable, and tough, as orange tan or raw hide softened. If compounded they may be run up to 9,000 feet velocity, but we do not see how the author makes out that compounding "deadens and counteracts centrifugal force," and for a 9,000 feet velocity to be economical we consider a belt must have a more than usual working-tenacity per unit weight as 7,000 is usually considered quite an outside velocity taking centrifugal stresses into account.

The flesh side should run next the pulley; it is the stronger, but if overloaded the grain or hair side should be next the pulley, as it will better stand the overheating due to slip. Belt thickness must not exceed a given ratio to the pulley diameter. A 4-inch pulley must not carry a belt above ¼-inch thick. Up to 8 inches a belt may be $\frac{5}{32}$-inch thick, thin $\frac{3}{16}$-inch up to 12 inches, and ¼-inch bare up to 18 inches diameter. Above 18 inches heavy leather can be used. We publish Mr. Tullis's table of belt powers and speeds in full.

PULLEY AND BELT-POWER TABLE,

showing what horse-power 1 inch in width of single or double leather belt will transmit when running on pulleys from 1 foot diameter to 10 feet diameter:—

SINGLE LEATHER BELTING.

1	in.	width	of	single	belt	on	pulley	6	in. dia. at 6,400 ft. belt speed per min. 1 H.P.
1	"	"	"			12	"	3,200	" " "
1	"	"	"			18	"	2,300	" " "
1	"	"	"			24	"	1,500	" " "
1	"	"	"			30	"	1,240	" " "
1	"	"	"			36	"	1,066	" " "
1	"	"	"			42	"	950	" " "
1	"	"	"			48	"	800	" " "
1	"	"	"			60	"	680	" " "
1	"	"	"			72	"	533	" " "
1	"	"	"			84	"	457	" " "
1	"	"	"			96	"	400	" " "
1	"	"	"			108	"	355	" " "
1	"	"	"			120	"	250	" " "

DOUBLE LEATHER BELTING.

1	in.	width	of	belt	on	pulley	18	in.	dia. at 1,333 ft. belt speed per min. 1 H.P
1	"	"	"				24	"	1,000 " " "
1	"	"	"				30	"	875 " " "
1	"	"	"				36	"	730 " " "
1	"	"	"				42	"	625 " " "
1	"	"	"				48	"	500 " " "
1	"	"	"				60	"	400 " " "
1	"	"	"				72	"	335 " " "
1	"	"	"				84	"	286 " " "
1	"	"	"				96	"	250 " " "
1	"	"	"				108	"	222 " " "
1	"	"	"				120	"	200 " " "

The above figures contemplate durability. A belt will do 30 per cent. more than the table without slip, if kept a little tighter and in good condition. Even twice the power can be transmitted at high tension, but a belt ought to do its duty when slack. Its "slack" side ought to be distinctly slack. Mr. Tullis would save pulley cost by using compound belts. Two 20-inch belts will do more than one 40-inch belt on a wide pulley. Superposed belts check surging and air cushioning. The top belt really is working on a leather pulley, and the under belt is being held against its pulley firmly.

Mr. Tullis advances instances of the benefit from compounding insufficiently strong belts. In our own practice we well remember where certain 4-inch belts were continually giving trouble. We changed them for 5-inch belts and the trouble ceased. All Mr. Tullis's examples are to the effect that by means of placing one belt over another, the work done may be increased in fully the ratio of leather used, and such compound belts are altogether satisfactory, and may even be used as shifting belts with strap forks, &c.

In quarter twist drives the ordinary flat belt, especially in a short drive, has one edge of the belt badly strained. This fault is got over by making special belts with one side longer than the other. So made they work perfectly, and may also be compounded. They ought to be of thin leather.

For really heavy work link belting is advised. It ought to have a flexible centre as it will then fit the crowning of the pulleys and do 30 per cent. more than if flat; but here again Mr. Tullis is wrong in saying that on such a belt centrifugal force has no effect. Such belts should not be tightened until they slip, unless the slack side sags down to touch the tight side.

The breaking strain of a link belt ⅝-inch thick is given as 1,400 lbs. per inch of breadth for oak tanned and 1,800 lbs. for orange tanned.

On tapered cones a link belt made to fit the cones will work without trying to climb against the shifter. Some such belts are made for steep pitched cones, which have a cross section varying from ⅝ to 2½ in a width of 6 inches. Such belts are, of course run half-twisted. If an open drive must be used then a full twist must be put on to both sides of the belt so as to get the correct arrangement of the taper of the belt upon the cones.

A little belt slip may sometimes be desirable, as, for example, when driving a dynamo from a gas engine when a little slip prevents surging and waves in the belt.

(To be continued.)

* This sentence does not occur in the original.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Design of Electric Railway Motors for Rapid Acceleration. By Prof. Charles A. Carus-Wilson, Member. Read May 26th, 1898.

The torque on the shaft of a motor may be expressed by the equation,

$$t = 1{\cdot}41\, p\, \text{A}\, \text{C}\, \text{N}\, 10^{-8} \text{ inch-pounds} \qquad (1)$$

where N is the number of C.G.S. lines per pole, A is the number of surface conductors, C is the total current passing into the motor, in amperes, and p is a numerical constant depending upon the way in which the armature is wound. This equation may be written,

$$t = 1{\cdot}41\, \text{C}\, \text{M} \qquad (2)$$

where M is given by

$$\text{M} = p\, \text{A}\, \text{N}\, 10^{-8} \qquad (3)$$

We shall call M the *induction factor* of the motor. Since the tension, e, induced at n revolutions per second is given by

$$e = \text{A}\, \text{N}\, n\, 10^{-8} \text{ volts} \qquad (4)$$

the induction factor may be found by dividing the induced tension in volts by the speed in revolutions per second, and the induced tension is given by the product of the induction factor and the speed.

The constant, p, may be defined as the ratio of the number of surface conductors in series between the main terminals to the number of surface conductors lying between two adjacent neutral points, and is unity for a bipolar machine, whether drum-wound or ring-wound.

When a motor is running at n revolutions per second, and taking a current of C amperes, we have the following expression for the speed:—

$$n = \frac{\text{E} - \text{C}\, \text{R}}{\text{M}} \qquad (5)$$

where E is the terminal tension in volts, and R is the resistance of the motor in ohms measured between the same points as the tension. Hence, in the case of a railway motor, the speed in feet per second is given by

$$s = 0{\cdot}262\, \frac{d}{\text{M}\, v} (\text{E} - \text{C}\, \text{R}) \qquad (6)$$

where v is the ratio of the speed of the motor to that of the main axle—afterwards called the velocity ratio—and d is the diameter of the driving wheel in inches.

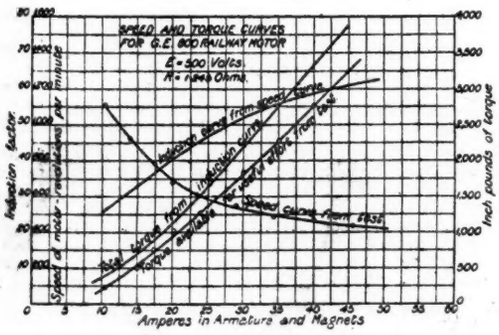

SPEED AND TORQUE CURVES FOR G.E. 800 RAILWAY MOTOR
E = 500 Volts.
R = 1·048 Ohms.
Induction curve from speed curve
Total torque from induction curve
Useful torque available
Speed curve from E.S.E.
Induction factor
Speed of motor - revolutions per minute
Inch pounds of torque
Amperes in Armature and Magnets

Fig. 1.

If an experiment be made in which the speed, the tension of the line, and the current are observed, we can find from equation 5 the value of the induction factor for different currents, and thus obtain what we shall call the *induction curve*. Such a curve is given in fig. 1, for the "G.E. 800" railway motor made by the General Electric Company.

From the induction curve we can deduce the curve of total torque for different currents. This curve will lie above that obtained by measuring the torque at the rim of the brake-wheel, the difference for any current representing the torque expended in overcoming friction of gearing, hysteresis, &c. The ratio of the two ordinates for any current gives the mechanical efficiency for that current.

If the current passing through the motor at any instant is greater than that required to overcome the frictional and other resistance to motion, the motor will accelerate, and the acceleration in feet per second will be given by

$$a = 405 \times 10^{-4}\, \frac{\text{M}\, v}{d}\, \frac{\text{C}_a}{\text{W}} \qquad (7)$$

where C_a is the current in amperes available for acceleration, and W is the whole weight that has to be accelerated, in tons of 2,240 lbs.

As an illustration, we may take the motors used on the Baltimore and Ohio Railroad. The conditions are as follows:—A train weighing 780 tons has to start from rest on a grade of 0·8 per cent. The train is drawn by a locomotive equipped with four motors permanently connected in series. The driving wheels, which are gearless, have a diameter of 62 inches. The maximum current from the line is limited to 1,800 amperes, and the mean value of M while the motors are starting may be taken as 155.

The tractive effort per motor required for the grade is 3,490 lbs., and for friction, allowing 9 lbs. per ton, 1,755 lbs., making altogether 5,245 lbs. If we allow 95 per cent. mechanical efficiency, we find from equation 2 that the current required to overcome friction must

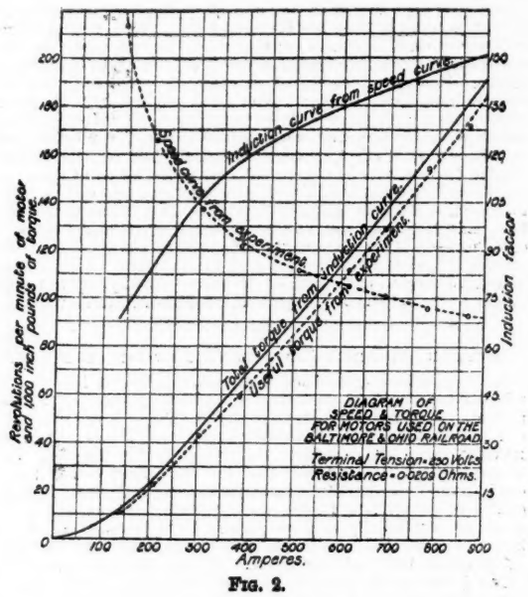

Induction curve from speed curve
Speed curve from experiment
Total torque from induction curve
Useful torque from experiment
DIAGRAM OF SPEED & TORQUE FOR MOTORS USED ON THE BALTIMORE & OHIO RAILROAD.
Terminal Tension = 250 Volts
Resistance = 0·0203 Ohms.
Revolutions per minute of motor and 1000 inch pounds of torque.
Induction factor
Amperes.

Fig. 2.

be equal to 780 amperes, leaving 1,020 amperes available for acceleration. Under these circumstances the train will start up from rest with an acceleration of 0·53 f.p.s. per second. The induction curve of these motors is given in fig. 2, and the current-curve observed in starting is given in fig. 3.

If a pulley of d centimetres diameter is placed on the shaft of a motor of induction factor M, carrying a current of C amperes, the tangential force at the rim of the pulley is given by

$$\text{T} = \frac{1}{\pi\, d}\, \text{M}\, \text{C}\, 10^7 \text{ dynes} \qquad (8$$

If $d = \frac{1}{\pi}\, 10^7$ centimetres, this may be written,

$$\text{T} = \text{M}\, \text{C} \text{ dynes} \qquad (9)$$

The force of a motor may thus be defined as a force of M C dynes at the rim of a pulley 10^7 centimetres in circumference. We shall call M C the *force factor* of the motor. Thus, in the preceding

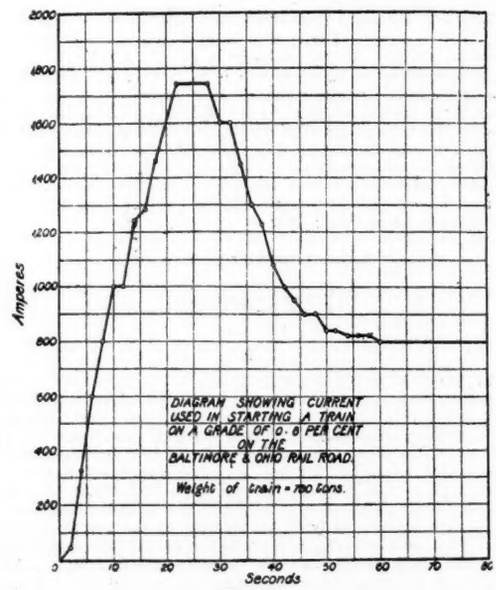


DIAGRAM SHOWING CURRENT USED IN STARTING A TRAIN ON A GRADE OF 0·8 PER CENT ON THE BALTIMORE & OHIO RAIL ROAD.
Weight of train = 780 tons.
Amperes
Seconds

Fig. 3.

example, each of the four motors must have a force factor of 279 kilodynes in order to start up with an acceleration of 0·53 f.p.s. per second.

The rating of a motor in horse-power gives us no indication of its ability to accelerate, though this may be the most important function it is called upon to perform. Thus, in the last example, the

horse-power of the motors at the moment of starting is nothing. In the problem that we now propose to discuss we shall find it convenient to be able to define the action of a motor in terms of a force unit instead of a power unit, and for this purpose we shall make use of the force factor. We may note in passing that the power in kilowatts at any moment is given by multiplying the force factor in kilodynes by the number of revolutions per second.

When a given distance has to be covered, we may divide the whole period of motion into two parts—that of acceleration and that of uniform speed. For the present we shall assume that, if there are two or more motors in the locomotive, they are connected in parallel, and that they speed up with uniform acceleration until full speed is reached.

From equations 6 and 7 it appears that, if everything else remains unchanged, the acceleration increases directly, and the final speed inversely, as $\frac{M v}{d}$. For example, if we keep M and v the same, we can increase the acceleration by putting on a smaller wheel, but we shall thereby reduce the final speed. The accelerating period will then be small, and most of the distance will be covered at full speed.

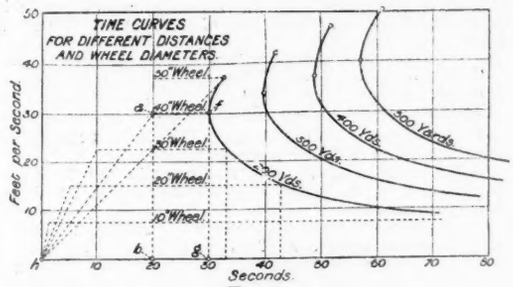


FIG. 4.

On the other hand, if we increase the diameter of the driving wheel, we shall get a small acceleration but a high final speed; most of the distance will then be covered during the process of accelerating, and full speed may not be reached before the given distance has been traversed. Similarly, if we vary the velocity ratio, keeping M and d the same, we shall get the reverse of these results. Or, if we keep v and d fixed and vary M, we shall get the same results as if we varied the velocity ratio.

In fig. 4 the horizontal axis represents seconds, and the vertical axis speed in feet per second. Let us suppose that the conditions are such that with a driving wheel 40 inches in diameter an acceleration of 1·5 f.p.s. per second is obtained, and that the final speed is 30 feet per second. A distance of 200 yards will then be covered in 30 seconds, 20 seconds being occupied in accelerating, during which time 100 yards is covered, the remaining 100 yards being covered in 10 seconds at full speed.

If now we replace the 40-inch wheel by one whose diameter is 30 inches, we increase the acceleration to 2 f.p.s. per second, but reduce the final speed to 22·5 f.p.s., so that it takes 33 seconds to travel 200 yards. If we put on a 50-inch wheel, the acceleration is decreased to 1·2 f.p.s. per second, and full speed is only just reached when the 200 yards has been covered, the time being nearly 33 seconds.

If a line, such as $a f$ in the figure, is drawn to a point at which the given distance is covered, the points thus found by using wheels of different diameters will lie on a curve. We shall call this the *time curve*. In the figure, dotted lines such as $h a$ represent the accelerating period, and dotted lines such as $a f$ the period during which the motors are running at full speed. The area $h a f g$, then, represents the whole distance covered in the time $h g$.

Time curves have been drawn for distances of 200, 300, 400, and 500 yards. An increase in the value of M or of v gives the same result as a decrease in the value of d.

It is evident that there is a certain value of $\frac{M v}{d}$ for which the time occupied in covering any given distance is a minimum. This value we shall now proceed to find.

We know from equation 7 that the acceleration varies inversely as $\frac{d}{M v}$. We may express this fact as follows:—

$$\frac{a b}{h b} = k_1 \frac{1}{\beta} \qquad (10)$$

where k_1 is a constant, and $\beta = \frac{d}{M v}$.

From equation 6 we have

$$a b = k_2 \beta \qquad (11)$$

where k_2 is a constant.

If D is the whole distance in feet that has to be covered, we have

$$D = \tfrac{1}{2} \frac{k_2^2}{k_1} \beta^3 + k_2 \beta \times b g \qquad (12)$$

hence, by substitution, we get

$$t = \frac{D}{k_2 \beta} + \tfrac{1}{2} \frac{k_2}{k_1} \beta^2 \qquad (13)$$

where t is the time occupied. To find what value of β makes the time a minimum, differentiate and equate to nothing, and we have

$$\beta^3 = \frac{k_1}{k_2^2} D, \text{ or } b g = \tfrac{1}{2} b h$$

The given distance then is covered in the shortest time, when the equipment is such that the distance travelled during the process of acceleration is equal to that travelled at full speed, the time of accelerating being two-thirds of the whole time.

Substituting for k_1 and k_2 their values as given by equations 7 and 6, we get

$$\left\{ \frac{d}{M v} \right\}^3 = 0{\cdot}59 \frac{D}{W} \frac{C_a}{(E - c_f R)^2} \qquad (14)$$

It appears, then, that, when a train of weight W tons has to be started from rest and moved through a distance of D feet, the tension of the line being E volts, the accelerating current c_a amperes, and the internal drop when running at full speed c_f R volts, the time occupied is least when the ratio $\frac{d}{M v}$ is that given by equation 14; and that, if this value of $\frac{d}{M v}$ is adopted, half the distance will be covered in the process of accelerating.

Since the equation 14 gives the value of $\frac{d}{M v}$ for covering any distance in the least time for a given accelerating current, it follows that, when the time as well as the distance is given, the accelerating current will be least when half the distance is covered during acceleration.

For, if any other ratio of $\frac{d}{M v}$ is adopted than that which covers half the distance during acceleration, the time will be prolonged, and consequently a greater accelerating current required.

We have, then, two conditions to fulfil. First, half the distance must be covered at full speed in one-third the time. If we are at liberty, as we generally are, to adjust the value of the resistance so that the drop at full speed is independent of M, v, and d, we then have

$$\frac{M v}{d} = 0{\cdot}1747 \frac{t e}{D} \qquad (15)$$

where e is the induced tension at full speed, or the tension of the line minus the heat drop.

It thus appears that the ratio $\frac{M v}{d}$, which governs the design of the whole equipment, is given by the consideration that half the distance must be covered at full speed in one-third of the time.

The accelerating current can now be found from equation 7. We know that half the distance has to be covered in two-thirds of the time: this gives us the acceleration. We know also the value of $\frac{M v}{d}$, and of W: hence we deduce,

$$C_a = 55{\cdot}5 \frac{D W}{t^2} \frac{d}{M v}, \qquad (16)$$

or we may write at once,

$$C_a = 318 \frac{D^2 W}{e t^3}. \qquad (17)$$

If we know the retarding forces at full speed we can find the current, since $\frac{M v}{d}$ is fixed, and hence we can obtain the resistance of the motor.

For example, suppose that we have to design an equipment by which a tramcar weighing 10 tons can be started from rest and moved through 500 feet in 30 seconds. We may suppose, further, that two motors are to be used, connected in parallel throughout; that the tension of the line is 500 volts, and the drop at full speed 9 volts.

From equation 15 we obtain the value of $\frac{M v}{d}$, and find it to be 5·15. We may assume for the present that v is limited to 4·78, and that d is 33 inches; hence M = 35·5. The maximum speed is 25 feet per second, or 17 miles per hour. If the frictional and other forces retarding the motion are equal to a torque of 3,580 inch-pounds on each axle, the current at full speed will be 15 amperes, and the resistance of each motor 0·6 ohm.

(To be continued.)

PHYSICAL SOCIETY.

MAY 27TH MEETING.

MR. CAMPBELL SWINTON read a paper on "Some Further Experiments on the Circulation of the Residual Gaseous Matter in Crookes Tubes." In the discussion that followed the former paper on this subject, at the Physical Society on March 25th, 1898, Mr. Appleyard had suggested that, in tracing the cause of the rotation of the exploring mill, it would lead to simpler results if the vanes were made of some light conducting substance, for it was probable that mica introduced complications by retaining the charges. Prof. Boys then pointed out that the mica might be gilded. Such a tube has now been made by Mr. Wolff. With the gilded mica vanes so placed as to be outside the cathode stream the mill behaves in a manner similar to

the non-conducting insulated mill. It shows a greater tendency to assume a position of stability, due to electrostatic induction, this renders it somewhat troublesome in starting, but, when once under way, the mill rotates always when excited. Occasionally, when starting, a few reverse revolutions are observed, these are probably due to electrostatic influence and momentum, and also possibly to eddy currents in the residual gaseous matter. But it is found, in all cases, that rotation in the direction that indicates a stream of residual gaseous matter from anode to cathode, follows the reversal immediately after one or two oscillations. An electrometer connected to the mill, through the pivot and needle-point, shows the vanes to be always electrified positively. The results are confirmed by a second tube with oblique vanes. The author concludes that at very high exhaustions there exists a molecular or atomic stream from anode to cathode, which carries a positive charge and travels at high velocity outside the opposite cathode stream.

Mr. J. Quick asked what was the minimum degree of exhaustion required to produce these results.

Prof. Boys said that the experiments gave some amount of probability to the truth of Mr. Campbell Swinton's hypothesis, but it did not altogether prove the mechanical theory of rotation to be correct. He was glad that the chance suggestion at the last discussion had led to such interesting experiments being continued.

Prof. Threlfall mentioned that Boettger had devised a method for gilding mica, by a chemical process, that was much to be preferred to ordinary gilding.

Mr. Campbell Swinton said it was necessary to exhaust the tubes as completely as possible, to a point where it was only just possible for any discharge at all to pass through them. If the rotation was due to electrification, there must still be some mechanical process whereby the charges get to the vanes—a stream of residual gas satisfied that condition.

The Vice-President proposed votes of thanks and the meeting adjourned until June 10th.

TRANSATLANTIC CABLES.

Messrs. Siemens Bros. have kindly permitted us to publish the following tabular statement of calculated and actual speeds compiled by them of Atlantic cables. It will be noticed that in the 1894 cables, which are of different lengths, and varying weights of copper and insulation, the advantage would be with the manufacture of Messrs. Siemens, length and weight of core being equal (see cols. 9 and 10).

As the earlier figures may require further notes to explain that the speeds given were by mirror or recorder, or by simplex and duplex, we have preferred to draw attention only to the two results directly comparable, viz., the 1894 cables:—

1	2	3	4	5	6	7	8	9	10	11
Date when laid.	Designation of cable.	Length in nautical miles.	Type of core of deep sea cable. Lbs. per naut. mile	K R. $\frac{\text{Ohm} \times \text{Microfarads}}{10_6}$	Calculated speeds taking 1874 cable at 20·2 words per minute.	Calculated speeds taking 1874 cable at 27·6 words per minute.	Speeds actually obtained in regular working.	Calculated speed if lengths 1,850 naut. miles.	Calculated speed if lengths 1,850 naut. miles and core 650/400.	Manufactured by
			Cop. G.P.							
1873	Anglo-American ...	1 876	400/400	3·919	18·11	24 75	...	...	...	Tel. Const. & Mtnc. Co.
1874	Anglo-American ...	1,837	400/400	3·512	20·20	27·6 (*f*)	20·2 (*a*)	19 9	28·2	Tel. Const. & Mtnc. Co.
1875	Direct United States	2,423	400/360	7·558	9·38	12·82	22·6 (*b*)	38·6	70·2	Siemens Bros.
1879	Pouyer-Quertier ...	2,242	350/300	6 600	10·74	14·67	22 (*c*)	32·2	59·8	Siemens Bros.
1866/80	Anglo-American ...	1,852	...	4·632	15 31	20 91	...	...	...	Tel. Const. & Mtnc. Co.
1881	Jay Gould	2,518	350/300	7 834	9 05	12 37	21·5 (*d*)	39·8	69·4	Siemens Bros. & Co.
1882	Jay Gould	2,563	350/300	8 030	8 84	12·08	21·5 (*d*)	41·2	71·2	Siemens Bros. & Co.
1884	Mackay-Bennett (S.)	2,353	350/300	6·740	10·52	14·37	26	42·0	72·3	Siemens Bros. & Co.
1884	Mackay-Bennett (N.)	2,346	350/300	6 630	10 71	14 63	26	41·8	71·2	Siemens Bros. & Co.
1894	Mackay-Bennett (3rd)	2,161	500/320	4·671	15·18	20·74	40 (*g*)	54·6	77 2	Siemens Bros. & Co.
1894	Anglo-American ...	1,850	650/400	2·420	29·31	40·04	47·4 (*e*)	47·4	47·4	Tel. Const. & Mtnc. Co.

(*a*) Report of engineers, Messrs. Clark, Forde & Co., to the manager of the Anglo-American Telegraph Company, dated June 25th, 1877.
(*b*) Report of engineers, Messrs. Clark, Forde & Co., to the manager of the Direct United States Cable Company, dated June 25th, 1877.
(*c*) Report of the engineer-in-chief, Mr. von Chauvin, to the Pouyer-Quertier Cable Company, dated June 15th, 1880.
(*d*) Report of Dr. Muirhead to Mr. von Chauvin, representative in London of the Western Union Telegraph Company, dated July 10th, 1883.
(i.) Special trial of code words, 18 words per minute } mean
(ii.) Press messages, usual rate, 25 " " " } 21·5
(iii.) As many as 135 letters per minute have been observed to pass at times without requiring repetition.
(*e*) *Electrician*, dated October 12th, 1894.
(*f*) Speed specified as basis for column 7 is taken from a letter from the manager of the Anglo-American Telegraph Company, dated September 20th, 1894.
(*g*) From a letter from Mr. G. G.-Ward, vice-president and general manager of the Commercial Cable Company, dated May 10th, 1895.

It will be noticed in column 8 that the actual working speed obtained with the cables made and laid by Siemens Bros. & Co., is very much greater than that calculated upon, even allowing for all the progress in manipulation and manufacture. Columns 9 and 10 prove this even more clearly, the figures given there having been calculated (from actual speeds) according to well-established formulæ—column 9 showing what the speed would be if all the cables were only 1,850 nautical miles long, and column 10 if the length and weight of core of all the cables were the same as those of the 1894 Anglo Cable.

THE "FULMEN" ACCUMULATOR.

We know that accumulators intended for electro-mobiles should above all possess a high *specific power* (watts per kilogramme of *total* weight) and a high *specific energy* (watt-hours per kilogramme of *total* weight) in order to reduce as far as possible the dead weight carried, and so to increase the length of the journey that the battery enables us to make without recharging. These figures are now pretty well established for certain types of accumulators, and we find under the signature of one of the best authorities on *automobile locomotion*, M. Ed. Hospitalier, a very competent article on the "Fulmen" accumulator, which is already well known to our readers. This article describes the progress realised in apparatus for the storage of electrical energy during the past 15 years.

The type that we have examined, says M. Ed. Hospitalier, is distinguished by the symbol B_{13} and comprises 13 plates: 6 positive and 7 negative. The plates, which are rectangular, are 18½ centimetres high, 9½ wide and 4 millimetres thick. They form a block consisting of 24 rectangular cells, in which is lodged the active material. Thin sheets of celluloid prevent the plates from coming in contact with one another.

The moist plates cut level with the fastening gave us the following respective weights of the grid and of the active material (in grammes).

	Positive plate.	Negative plate.
Grid	135	135
Active material ...	340	255
Total weight	475	390

The surface of each plate is 1·75 square decimetres of the total surface for the 12 faces of the six position plates.

The celluloid trough and the partitions separating the plates weigh 600 grammes. The total weight of the complete element with the liquid is 7·5 kilogrammes.

M. Brault, administrator and delegate of the Fulmen Accumulator Company, considers the normal *régime* of discharge equivalent to a current of 21 amperes corresponding to a continuous discharge of 5 hours, or a density of current of 1 ampere per square decimetre of surface of the positive plates, but the accumulator can, at the expense of its capacity, supply as much as 50 amperes of continuous discharge and 100 amperes in interrupted discharge, for a special strain, for instance.

With the normal discharge in 5 hours the mean available difference of potential of the element is 1·9 volts, and the capacity 105 ampere-hours. Each element of 7·5 kg. supplies at the normal *régime* 40 available watts and contains an available energy equal to 200 watt-hours.

The specific constants of the element are, therefore, as follows, as compared with the *total* weight:—

Specific output, in amperes, per kg.	3
Available specific power, in watts, per kg. ...	5·3
Specific capacity, in ampere-hours, per kg. ...	146
Available specific energy, in watt-hours, per kg.	26
Specific weight in kilogrammes per kilowatt ...	190
Specific weight in kilogrammes per kilowatt-hour	37·5

At the *régime* of 5 watts per kg., the Fulmen accumulator contains, therefore, more than 25 watt-hours per kg. These two figures are sufficient to calculate the weight of accumulators necessary to work an automobile of a given total weight, at a given speed on a given track, the efficiency of the motor and the transmission being known, and also the road to be traversed between two successive charges. If the *régime* of continuous specific discharge be doubled and brought to 10 watts per kilogramme, the specific energy falls to 20 watt-hours per kilogramme. If we do not require more than 100 kilogrammes of accumulators to produce 1 kilowatt, we

should require 50 kilogrammes (instead of 40) to store up 1 kilowatt-hour.

If, on the contrary, we reduce by half the specific *régime* of continuous discharge, the available specific energy increases and attains to 30 watt-hours per kilogramme.

In calculating the weight of a battery, therefore, we must not lose sight of the fact that we lose in energy what we gain in power, and *vice versâ*, and that accumulators wear much better when they are subjected to more moderate *régimes* of discharge. In their special application to electro-mobiles, the discharge is not continuous, but, on the contrary, extremely variable, and interrupted by intervals of rest favourable to the diffusion of the liquid, which diffusion is also facilitated by the agitation of the elements during the journey. The figures given for the normal *régime* may therefore be accepted as representing the energy actually available, notwithstanding the variations in the output.

As regards the duration of the elements we can give no figures as there is too great a difference between the conditions under which they work in the laboratory and on the road. We shall gain more information on this important point as electro-mobiles become more extensively used.

We had intended to publish the conditions of working of other types of accumulators applied to automobiles, but we found that they were nearly all considerably inferior to those we have just described relating to the "Fulmen" accumulator. As each maker or inventor claims in favour of his apparatus special advantages as to solidity, duration, cheapness, facility of arrangement, &c., which more or less compensate for inferiority in output and capacity, we did not think it expedient to challenge claims and contradictions.

The figures which we have given, and which are deduced from our own experience, represent the maximum of what can be obtained from the *present* accumulators while we are waiting for better, in defiance of the proverb that says "Let well alone."

The accumulator question is attracting universal attention just now, and we would readily believe that the present maximum is merely provisional. But such as it is, it enables us to realise practical electro-mobiles capable of making daily journeys of 50 to 60 kilometres without being recharged.

The competition for electric cabs to be held by the Automobile Club in June, will be a reliable experimental confirmation of our deductions.—*L'Energie Electrique.*

REVIEWS.

Treatise on Chemistry. Vol. II.—The Metals. By Prof. Roscoe and Schorlemmer. London: McMillan & Co., Limited. 1897.

This is the third edition of one of the most important volumes in the great work first issued by the authors in the early part of 1878. During the 19 years which have elapsed since the publication of the first edition of this volume, much important work on the chemistry of the metals and their compounds has been done. So much, indeed, that the time was ripe for a new edition in which the metallic elements and their compounds should be re-arranged and all new matter of importance added. Prof. Roscoe and his assistant have had a large mass of material from which to make their selection, and on the whole, those who are familiar with the first two editions will conclude that they have generally exercised their judgment well, and have not failed to realise the significance of the new discoveries.

The new edition is more bulky, but fortunately, it has been possible to condense much of the old matter and even to reject some, so that the volume before us is not too ponderous. This is a great advantage, for, in the early editions, the metals used to be dealt with in two volumes.

To review this work from the point of view of the metallurgist is scarcely within our province, but we have no doubt whatever that those who are interested in the chemistry of metals will give a whole-hearted verdict in favour of this new edition, which we are sure they will find to be a veritable mine of unusually accurate information.

A treatise on the metals, their chemical and physical properties, would not be complete without alluding in the proper places to the achievements of those who have sought to increase our knowledge of electricity within the past 20 years, and this has been done to some extent. We humbly suggest, however, that the work would have been far more valuable if the editors had drawn more copiously upon these achievements and had made more of them. We even venture to say that the work would have been more valuable if an electrical engineer thoroughly conversant with the researches of the past 20 years had been associated with them in their labours, for the purposes to which the metals are now placed in the electrical industries are so numerous and important that they cannot be overlooked. It is only in this direction that we can detect any serious weakness, otherwise the work is, humanly speaking, complete.

In a treatise on the metals, extending to nearly 12,000 pages, one might surely expect more than a page on the subject of conductivity; this is all that is devoted to it, and the subject is only considered with conductivity for heat under the heading of "Physical Properties in relation to the Periodic System." Actually in describing the physical properties of silver, we are only informed that it is the best conductor of electricity; and under the physical properties of copper, the only statement is that next to silver it is the best conductor of electricity, and that pure copper is very largely employed for electric light mains and subterranean constructions, and that small quantities of impurities lower the conductivity to a large extent. We should have thought that metals possessing this property to such a high degree would have been written about somewhat differently, and that wherever the physical properties of metals were stated, the values of their electrical conductivities would have been given. But we have searched for them in vain. Generally speaking there is a great dearth of physical constants.

Another instance of unbalanced treatment in dealing with electrical matters is to be found on page 319, where the electrolytic preparation of copper is described in 18 lines, yet the electrotyping process, which is surely a matter of less importance, receives more than two pages.

In dealing with the velocity of reaction we miss any reference to recent German researches on the velocity of ions.

Spectrum analysis and the methods of producing emission spectra are very fully dealt with as might be expected from one who has done so much himself in this direction; indeed, this part of the work is very complete.

There is a very good section on the constitution of salts and bases in dilute solution, but, strange to say, no reference to Arrhenius, Nernst, and the other great investigators in this field of research. It seems impossible to have omitted a full explanation of the electrolytic dissociation hypothesis, but such is the case. Indeed, the editors of this edition do not seem to have realised the important progress which has been made in electrolysis, not only as regards theoretical matters, but in practice; and so we look in vain for any reference to recent achievements in the direction of producing chlorates, hypochlorites, &c., in this way.

We should have thought that the work would not have gone to press too soon to have included some reference to Karl Elb's recent research on electro-chemistry. We miss him in common with many others of greater and less rank.

The authors had a great opportunity when writing up aluminium, but they do not call our attention to the phenomenal progress which has been made in the industrial application of this metal during the past 7 or 8 years, and the electrolytic production of aluminium is dismissed in about half a page. Some of the data too are wrong. We might have been favoured with the authority for the statement that the electrical energy required for the production of 1 lb. of aluminium amounts to 3,730 watt-hours. In describing the Héroult process in use at Foyers, the statement is made that the alumina is melted without the addition of a flux, and is then simply electrolysed. But the fact is, that alumina itself is practically infusible, though it dissolves readily in several salts which melt at a reasonably low temperature. In practice cryolite is found to be the most suitable with the Héroult cells, and this is used by the British Aluminium Company. The bath is filled with molten cryolite which is constantly fed with alumina as the aluminium is deposited. If the cryolite is not a flux, it is certainly a solvent for alumina and most, if not all, will imply this if they speak of cryolite as a flux. Loose statements of this kind ought not to have crept into such a work.

Turning to platinum we find as, indeed, we do with nickel and others of the metals which are more interesting to our industry, that data which we may reasonably expect to be present are conspicuous by their absence. The position of platinum in the electrical industries ought certainly to have been defined.

The last chapters in the book deal with the newly discovered elements of helium and argon, and practically con-

stitute abstracts of the more important papers which have appeared, and with which our readers are familiar. We were expecting too much, perhaps, when we looked for some pronouncement on the fact that the existence of these two elements is not in any way indicated in the periodic arrangement of the elements, yet it is probable that their discovery will lead to modifications of that hypothesis.

As a treatise on chemistry, the work will probably satisfy chemists and also metallurgists of the older school, but the up-to-date metallurgist and especially electrical engineers who are interested in electrolysis will find it somewhat disappointing.

The book is executed in Messrs. McMillan's well known style, it is well printed, well illustrated, and suitably bound, and though as a treatise not perfect from our point of view, will, we are quite sure, be welcome wherever the chemistry of the metals is studied.

Alternating Currents of Electricity. By ALFRED STILL. London: Whittaker & Co. 1898.

This book, says the author, is written less from a scientist's point of view, and more from an engineering standpoint, than is usually the case; and not only for engineering students, but also for those engineers who are but slightly acquainted with alternating current problems.

There are, doubtless, many electrical engineers who, while possessing an extensive practical acquaintance of alternating current machinery, are ignorant of, or, at any rate, have but hazy notions of the principles underlying the design and working of such apparatus. To write a book meeting the requirements of this class of reader demands an author whose knowledge of the subject is good in both theory and practice, and who at the same time possesses the aptitude of expressing his ideas simply and clearly.

As far as we can judge, Mr. Still appears to satisfy all these requirements. His production is undoubtedly one which will appeal to a large class of readers. His preface is a little misleading where he states that the introduction of mathematics has been entirely avoided, since there are instances of the use of differential coefficients to denote rates of change; but such insertions are so carefully explained that no exception can be taken to them.

In the explanation of the various phenomena due to self-induction, capacity, &c., liberal use is made of graphical methods.

In general, the explanations given are scientifically sound and clearly stated. On page 119, however, the explanation of the constancy of the cycle of magnetisation in a transformer core for varying secondary loads is rather loose. We presume Ohm's law has an extended meaning given to it here. Moreover, would Ohm's law necessarily be violated in the primary, if, on increasing the secondary load, the maximum value of the induction varied? This is, however, but one unsatisfactory passage in an otherwise uniformly excellent production. The book is well written, aptly illustrated, clearly printed, and free from typographical slips. We can heartily recommend Mr. Still's book to the class of readers for which he has ostensibly written it.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. THOMPSON & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*

11,153. "Improvements in electric arc lamps." SIEMENS BROS. and Co, LIMITED. (Siemens & Halske, Aktien-Gesellschaft, Germany.) Dated 16th May. (*Complete.*)

11,154. "Improvements in self-regulating driving pulleys applicable to the driving of a dynamo from a railway carriage axle and for other purposes." E. J. PRESTON. Dated May 16th.

11,155. "Improvements in secondary batteries or accumulators." F. KING. Dated May 16th.

11,157. "Improvements in alternating current motors." W. LANGDON-DAVIES. Dated May 16th.

11,175. "Improvements in switches for electric circuits." C. B. CALLOW and J. ECK. Dated May 17th.

11,185. "Improvements in starting devices for monophase electric motors." E. B. WEDMORE. Dated May 17th.

11,255. "An improved means or apparatus for reducing or extinguishing the electric arc formed on breaking electric circuits.' R. H. FOWLER, C. J. HALL, and R. ACOCK. Dated May 17th.

11,278. "Improvements in step-by-step printing telegraphs.' W. S. STELJES. Dated May 17th.

11,282. "Improvements in electric check clocks or alarm signal apparatus." H. REICH. Dated May 17th.

11,290. "Improvements in electric arc lamps." P. R. JACKSON AND Co., LIMITED, and L. C. H. MENSING. Dated May 17th.

11,292. "A new and improved electrical gas lighter." J. DE MEZA. Dated May 17th.

11,293. "A new and improved theatrical ticket or check." A. MARSH. Dated May 17th.

11,302. "Improvements in or connected with electrical switches." A. BRIER. Dated May 18th.

11,307. "Improvements and modifications in the construction of amperemeters, voltmeters, wall meters, or the like." A. SPARK. Dated May 18th.

11,320. "Improvements in electrical ignition apparatus for gas burners." R. J URQUHART. (The Actien-Gesellschaft fur Fabrikation von Broncewaaren und Zinkguss, vorm. J. C. Spinn & Sohn, and S. J. von Romocki, Germany.) Dated May 18th.

11,326. "Improvements in adjustable reels, leads, and other similar purposes." W. H. STURGE. Dated May 18th.

11,340. "Improvements in or connected with electric batteries." E. A. JAHNCKE. Dated May 18th.

11,353. "Improvements in or connected with commutators for dynamo-electric machines and electric motors." C. J. FERGUSON and G. T. FERRELL. Dated May 18th.

11,360. "Improvements in globe holders for enclosed electric arc lamps." K. WEINERT. Dated May 18th.

11,396. "Method of producing foot-plates for electrotypes, stereotypes and the like and foot-plates thus produced." V. H. HOLM. Dated May 19th.

11,416. "Improved method of and apparatus for signalling or advertising by electricity." A. GINISTY and V. METZ. Dated May 19th.

11,426. "Improvements in electrically propelled vehicles." The HON R. T. D. BROUGHAM and W. C. BERSEY. Dated May 19th.

11,429. "Improvements in electrically propelled road vehicles." O. PATIN. Dated May 19th.

11,433. "Improvements in prepayment electricity meters." F. F. YEATMAN. Dated May 19th.

11,438. "Improvements in electrical furnaces." SIEMENS BROS. AND Co., LTD. (Siemens and Halske Actien-Gesellschaft, Germany.) Dated May 19th. (*Complete.*)

11,440. "Improvements in dynamos." G. UNTERBERG. Dated May 19th. (*Complete.*)

11,455. "An improvement in automatic electric circuit breakers and restorers." G. E. FLETCHER. Dated May 20th.

11,498. "An improvement in holders for electric glow lamps." H. C. GOVER and C. F. PROCTOR. Dated May 20th.

11,499. "Improvements in resistance switches." H. C. GOVER and C. F. PROCTOR and A. H. BATE. Dated May 20th.

11,506. "Improvements in or connected with telephones." J. E. O. KUMBERG. Dated May 20th.

11,518. "Improvements in electrical lighting devices for kerosene and other burners." S. M. MEYER. Dated May 20th. (*Complete.*)

11,519. "Improvements in electric brakes." H. P. DAVIS. Dated May 20th. (Date applied for under Patents, &c., Act, 1883, Section 103, October 22nd, 1897, being date of application in United States.)

11,525. "Improvements in and connected with electrical switches." E. J. WADE and the ELECTRIC MOTIVE POWER COMPANY. Dated May 20th.

ELECTRICAL PATENTS OF 1884, EXPIRING IN JUNE, 1898.

We are informed by Messrs. W. P. Thompson & Co. that about 80 applications for electrical patents were filed in the month of June, 1884. Out of these applications some were never completed, and of those that were, not one has been maintained to run its full length of term, viz, 14 years, but became void after a period of a few years.